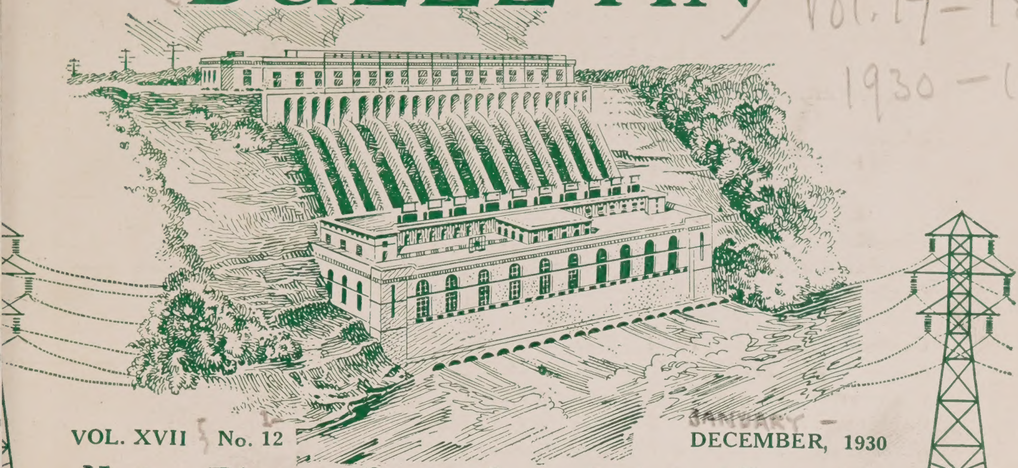
Ontario. Hydro-Electric Power Commission.

Hydro news

THE BULLETIN

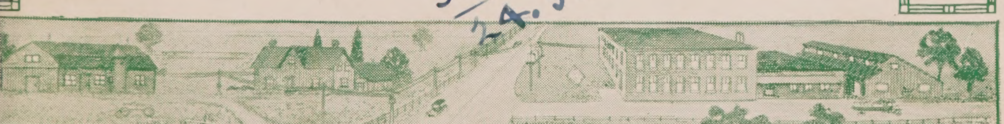
Vol. 17-18
1930-1931



VOL. XVII No. 12 DECEMBER, 1930

Hydro-Electric Power Commission of Ontario

Season's Greetings



HYDRO MUNICIPALITIES

EASTERN SYSTEM

Alexandria	2,284
Apple Hill	350
Athens	625
Belleville	13,914
Bloomfield	572
Bowmanville	3,630
Brighton	1,290
Brockville	9,322
Cardinal	1,254
Carleton Place	4,293
Chesterville	1,013
Cobourg	5,378
Colborne	907
Deseronto	1,380
Finch	334
Havelock	1,134
Kemptville	1,269
Kingston	22,368
Lakefield	1,469
Lanark	579
Lancaster	560
Lindsay	7,231
Madoc	1,091
Marmora	853
Martintown	357
Maxville	774
Millbrook	714
Napanee	2,983
Newcastle	615
Newburgh	434
Norwood	752
Omemee	511
Orono	700
Oshawa	24,194
Perth	3,712
Peterboro	22,798
Picton	3,266
Port Hope	4,468
Portsmouth	602
Prescott	2,724
Russell	500
Smith's Falls	7,105
Stirling	791
Trenton	5,800
Tweed	1,216
Warkworth	500
Wellington	832
Whitby	5,195
Williamsburg	200
Winchester	992
Total	175,835

GEORGIAN BAY SYSTEM

Alliston	1,329
Arthur	1,010
Bala	363
Barrie	7,365
Beaverton	1,018
Beeton	560
Bradford	915
Brechin	255
Cannington	889
Chatsworth	316
Chesley	1,803
Coldwater	610
Collingwood	5,652
Cookstown	635
Creemore	603
Dundalk	560
Durham	1,720
Elmvale	600
Elmwood	350
Flesherton	442
Grand Valley	546
Gravenhurst	1,846
Hanover	2,920
Holstein	285
Horning's Mills	350
Huntsville	2,670
Kincardine	2,352
Kirkfield	138
Lucknow	1,062
Markdale	797
Meaford	2,747
Midland	7,820
Mount Forest	1,911
Neustadt	408
Orangeville	2,679
Owen Sound	12,368
Paisley	730
Penetanguishene	3,985
Port Carling	420
Port McNicholl	879
Port Perry	1,150
Priceville	
Ripley	449
Shelburne	1,120
Stayner	967
Sunderland	570
Tara	453
Teeswater	813
Thornton	200
Tottenham	535
Uxbridge	1,417
Victoria Harbor	1,382
Waubaushene	600
Windermere	120
Wingham	2,266
Woodville	407
Total	85,787

MADAWASKA SYSTEM

Arnprior	4,033
Renfrew	5,217
Total	9,250

NIAGARA SYSTEM

Acton	1,973
Agincourt	350
Ailsa Craig	521
Alvinston	635
Amherstburg	3,017
Ancaster Twp.	4,124
Arkona	385
Aurora	2,596
Aylmer	2,050
Ayr	789
Baden	710
Barton Twp.	7,774
Beachville	503
Belle River	791
Blenheim	1,595
Blyth	641
Bolton	599
Bothwell	630
Brampton	5,100
Brantford	32,786
Brantford Twp.	7,301
Brigden	400
Bridgeport	500
Brussels	736
Burford	700
Burgessville	300
Caledonia	1,450
Campbellville	200
Cayuga	619
Chatham	16,104
Chippawa	1,450
Clifford	493
Clinton	1,936
Comber	800
Cottam	333
Courtright	416
Dashwood	350
Delaware	350
Dorchester	400

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Review of Hydro Activities During 1929

By C. A. Magrath, Chairman, H.E.P.C. of Ont.

AS the year 1929 draws to a close and it becomes possible to review its activities it is evident that the co-operative municipal undertaking administered by the Hydro-Electric Power Commission of Ontario as trustee for Ontario cities, towns, villages and townships has experienced a most satisfactory degree of prosperity. New records have been established with respect to increase in power demands, the extension of facilities for rural electrical service, reduction in costs to consumers, further strengthening of the financial position of the undertaking, and additional provision of power for future needs.

Up to the end of the Commission's fiscal year 1929—which closed on Oct. 31—the Commission's peak loads in firm contracts had reached 1,119,000 horse power, an increase over the same month in 1928 of no less than 153,000 horse power. Inasmuch as, in 1929, there were no large absorptions of other existing undertakings into the Commission's systems, the year 1929 has established a new record as regards the rapidity of expansion of the demands of existing consumers served through the "Hydro" undertaking.

In 1929 the new municipalities served by the Commission comprised 4 towns, 13 villages and 33 townships, bringing the total of the partner municipalities to 608. Although new municipalities are constantly being added to those already served by the Commission, they are necessarily of smaller size, and their inclusion makes no large yearly increase in the demand for power. The growth in load due to the inclusion of new municipalities is, therefore, of relatively minor importance, contrasted with the larger demand resulting from the collective increase in the demands of individual consumers. In this respect conditions may be said to have become practically stabilized, and the Commission, therefore, is even better able than

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before to determine the probable increase in loads and to make suitable provision for it.

It is believed that those interested in the expansion of industry in Ontario now realize more fully the great significance to the Province of having available at all times ample supplies of hydro-electric power under the conditions which characterize the operations of Ontario's co-operative municipal enterprise. Substantial reserves of power at attractive rates are now available to facilitate industrial growth. It is an important fact that approximately two-thirds of the power distributed by the Commission is applied to industrial activities.

The development of hydro-electric power in the last decade has made tremendous progress, largely because the present-day industrial leader appreciates the fact that the more mechanical power he can place at the service of his employees the greater will be his output. The result of such a policy is to improve the earning capacity of the worker—which should be to his advantage—and at the same time greatly to increase the wealth production of the country.

That adjustment of economic balance in the equitable apportionment of increased production among the workers, the consumers and those who provide the necessary capital for the power-consuming equipment is proceeding satisfactorily in Ontario is evidenced not only by the expansion of industry—reflected in the rapidity with which power demand is growing—but also by the rapidity with which the general prosperity is being diffused among all elements of the community. In this connection the Commission's experiences in the field of residential electrical service are of particular interest.

The records of municipalities served by the Commission, as published in the Commission's successive annual reports, indicate that the domestic consumption of 21 kilowatt-hours per month in 1914 increased to 115 kilowatt-hours in 1928. The large proportion of domestic consumers are wage-earners, and the above data are therefore evidence, not only of the increasing appreciation of the value of electrical service in the home, but also of the enhanced ability of the citizens to purchase a greater degree of comfort. The increased use of energy in the home implies a substantial investment in wiring and fixture supplies as well as in domestic cooking and other appliances—a development which must materially stimulate the activities and prosperity of the electrical and allied industries.

The contracts with the Gatineau Power Company provide for progressive increases year by year in the amounts of power to be taken. The Commission is now taking its full proportionate contract amount to date of 60-cycle power for the systems in Eastern Ontario, and is taking 20,000 horse power more than its proportionate contracted-for amount of 25-cycle power for the Niagara system. To take care of the additional load from the Gatineau Power Company, the Commission has constructed during the past year an additional 112 miles of single-circuit 220,000-volt line, constituting the western half of the second circuit of the transmission line extending from the Niagara system at Toronto to the Gatineau River. To take care of the rapid growth in load in the southwestern portion of the Niagara system, a new 110,000-volt transmission line 105 miles long was constructed from Niagara Falls to St. Thomas, following an almost direct route. During the year a tenth unit was purchased for the Queenston generating station and is being installed.

In order to provide additional power for the Georgian Bay system, more particularly for the Eugenia district, the Commission has made arrangements for constructing a 110,000-volt line from Kitchener (in the Niagara system) to Hanover, and for the installation of the necessary frequency-changer set at Hanover. During the year the new power development at Trethewey Falls was completed and placed in service. This has added 2,300 horse power to the power supply of the Georgian Bay system. In the Thunder Bay system progress has been made on the Alexander power development of 54,000 horse power capacity, whic his the second development on the Nipigon River. In the Nipissing system a new development at Elliott Chute on the South River was completed and placed in operation during the year, increasing the generating plant capacity of the system by 1,800 horse power. These constructional activities, with many others of less extent, are constantly being carried on to improve the service in all systems of the Commission, and involved new capital investments during the year amounting to about $10,000,000.

Like the industrialists, the farmers of Ontario are exhibiting a growing appreciation of the economic benefit to be derived by the application of electric power as a means of increasing the production from their properties without proportionate expense. The favorable experience of the agriculturists who have been making use of the service is clearly indicated by the manner in which rural electrical service expands. At the end of 1923, service had been supplied to about 4,200 rural consumers in fifty-two districts, requiring some 1,700 horse power from the Commission's lines ; by the end of 1928—the last year for which complete returns are available—there were, in the same 52 rural power districts, some 15,600 additional consumers with an aggregate power demand of 9,600 horse power. This remarkable growth must doubtless be attributed in large measure to the satisfactory experience of the earlier consumers as to the desirability and economy of the service. In the same five-year period, also, service was

inaugurated in 79 new rural power districts, serving more than 11,000 consumers. The total number of rural consumers now exceeds 37,000.

The relatively longer distances between consumers in agricultural territory than in cities and towns necessitate higher charges for rural electrical service in order to cover the greater costs of distribution, and intensive study by the Commission has been devoted to means of overcoming this handicap. The Government agricultural "grant-in-aid," amounting to one-half of the capital cost of rural distribution lines and equipment—made in recognition of the importance to the general welfare of the Province of improving the economic status of the basic industry of agriculture has been of material assistance in making economically feasible the extension of service in areas that could not otherwise have been served. This policy has furnished a stimulus to the extension of rural electrical service.

In 1929 the Commission constructed about 1,150 miles of line in rural power districts to serve 6,270 new consumers. During the coming year it is anticipated that possibly 1,500 miles of new line may be constructed.

The important developments which have been taking place in the Northern areas of the Province have resulted in demands for low-cost power, both for the needs of established communities and for the development of natural resources. The Commission is keeping in close touch with the power requirements of this northern country, and a comprehensive study is being made of the power needs of the territory extending westward from the upper Ottawa River. In connection with this program, the Commission has acquired by purchase certain electrical properties in the Madawaska district at present supplying the towns of Arnprior and Renfrew and the surrounding areas. The purchase included a number of important power sites on the Madawaska River, which will be available for future developments. In the Patricia district a generating station is being built at Ear Falls on the English River in the vicinity of the Red Lake mining district, and it is expected that January will see power available for distribution. This, it is hoped, will be a stimulus to development in this territory.

At the present time the total investments of the Commission in collective undertakings on behalf of the co-operating municipalities and the investments made individually by the municipalities in distributing systems and other electrical assets aggregate about $315,000,000. Year by year, under the cautious policy which characterizes the financial operations of Ontario's co-operative municipal electrical enterprises, the reserves of the undertaking have been steadily increasing. This is true with respect to investments made by the municipalities, both collectively and individually. Moreover, the reserves are increasing today at a more rapid rate than previously. As stated in the twenty-first annual report of the Commission, these reserves at the end of Oct., 1928, aggregated $76,280,000. The forthcoming annual report will, it is believed, show reserves aggregating about $88,000,000.

In addition to the automatic lowering of costs to consumers which results from the form of rate schedules in use, and has been the means whereby the average cost per kilowatt-hour to domestic consumers has been reduced, successively, from five cents per kilowatt-hour in 1914 to two cents in 1923, 1.80 cents in 1927, and 1.71 cents in 1928—and, it is anticipated, to a still lower figure in 1929—there have, with respect to power service, been put into effect during 1929 reductions in the rates themselves in no less than 150 municipalities.

The outstanding results which have been attained in 1929 and previous years in maintaining the adequate and economical supply of electrical energy that is essential to the development of the Province, would have been impossible had not the Commission, some years in advance of the materialization of the actual demand, laid plans after careful study of the relative advantages of possible sources of power, as well as of the trends of prospective consumptions. Similarly during 1929 the Commission has been taking steps to ensure that progress shall be unhampered in the future.

The Commission has unbounded confidence in Canada's future, and believes that, in view of the resourcefulness of its people, its strategic position in the world of commerce, its areas of lands awaiting more intensive settlement and its rich natural resources, Canada is destined to become a great industrial nation.

There is but one policy to be pursued where such conditions prevail, and that is to be prepared to meet the rapidly increasing demand for a stable and ample supply of low-cost power. The program that the Commission has been working on contemplates the securing of several hundred-thousand horse power to be put to use during the next few years. By the time this power is in use it is hoped that the citizens of Ontario will have on the St. Lawrence River a development to take care of their needs for some considerable period thereafter.

In short, the Commission's attitude is in line with the view generally held throughout Canada, that as a people we are determined to go ahead vigorously but sanely, having full confidence in the future.

The Beauharnois Agreement

THE annual increase in power demands to meet the Commission's growing requirements is now approaching 100,000 h.p. and will soon exceed that amount. Looking to future requirements for power the Hydro-Electric Power Commission of Ontario recently entered into an agreement with The Beauharnois Light, Heat and Power Company for the supply of up to 250,000 horse power, 25 cycle power, the first delivery to be made in 1932.

The power is to be delivered to the Commission at the Ontario-Quebec boundary, north of Lake St. Francis, at approximately 240,000 volts, the voltage to be varied as the Commission may instruct so as to meet operating conditions of the Commission's system. This power is to be delivered according to the following minimum schedule, which may be accelerated if required :

On October 1, 1932—35,000 h.p.
On October 1, 1933—40,000 h.p. additional
On October 1, 1934—54,000 h.p. additional
On October 1, 1935—67,000 h.p. additional
On October 1, 1936—54,000 h.p. additional

The total amount provided for in the contract will therefore be taken on October 1, 1936, all of which will be transmitted to the Niagara System.

The agreement is for the period of 40 years from October 1, 1932, and may be extended for an additional 40 years on mutual agreement between the Commission and the Company. The rate to be paid by the Commission for this power is $15.00 per horse power per year based on the contracted demand for power supplied.

The power will be generated in the Beauharnois section of 15 miles of the St. Lawrence River from Lake St. Francis to Lake St. Louis, where there is an 80 foot head. The following brief description of the proposed development is excerpted from *Electrical News and Engineering*.

"The Beauharnois section (or Soulanges section, as it is sometimes termed), besides being wholly within Canadian territory has 40 per cent. of the total potential horse power of the entire St. Lawrence. From an engineering standpoint it is the most economical section to develop and would naturally be the first section to be given attention. The development of this wholly Canadian section by private capital was first recommended by the National Advisory Committee, appointed by the Dominion Government five years ago, to advise on the development of the St. Lawrence. In 1926 the Joint Board of Engineers recommended a power and navigation development which would have utilized the existing bed of the river, but the appendices of the report advocated the present plan as a sound alternative.

The Beauharnois Light, Heat and Power Company takes its name from the small town of Beauharnois situated near the foot of the rapids on

Reproduction of a Bas-relief Map showing location of proposed Beaharnois Canal and Power Development.

Lake St. Louis, close to the site of the new power house. It may be of interest to know that the family of Beauharnois, the original seigniors of the neighborhood, dates back to the time of the Crusaders. Claude de Beauharnois de Beaumont came to Canada in 1729 and one authority says it was Charles, Marquis de Beauharnois, who, as governor of New France, was the first to originate a Beauharnois power project. During his life time which ended in 1749 he constructed a small canal connecting Lake St. Francis with the St. Louis River, a small stream flowing into Lake St. Louis, for the purpose of draining some swampy land and to permit the hydraulic development of the St. Louis River.

The promoters of the project had to negotiate with the provincial government of Quebec, who own the water rights on the river, and the Dominion Government, who have control of all matters affecting navigation. The company's charter includes, in addition to provision for graduated water rentals, clauses that provide that the new canal must be maintained in accordance with deep water navigation requirements. The company must cede to the Dominion government the land for the two necessary navigation locks and must provide power up to 3,500 horse power for their operation. The navigable channel must have a minimum depth of 27 feet and minimum width of 600 feet at the bottom. The cost of constructing this canal independent of the power project is estimated at $16,000,000.

The initial development at Beauharnois is for 500,000 horse power in 50,000 horse power generator units, the initial ten to be in operation by October, 1932. Further power will be developed as required in 50,000 horse power units by simply widening the canal and extending the power house.

Sleet Storms in Eastern Lake Erie Counties

By N. E. Macpherson, Municipal Engineering Dept. H.E.P.C, of Ontario

DURING the month of December a series of sleet storms occurred in southern Ontario, being particularly severe in the Counties of Welland, Haldimand and Norfolk, bordering Lake Erie. The first of these was on December 8th, the second on the 11th, after which there was no rise in temperature to relieve the ice loadings resulting from these storms.

On Tuesday, December 17th, rain was again followed by sleet coming from a general easterly direction. Trees, buildings and particularly telephone and Hydro lines, both rural and urban became further coated with ice. Following the sleet a driving snow storm from the northwest added to the already heavy load of ice on poles and lines. Loss of poles was confined almost entirely to telephone lines on account of the greater ice load on the larger number of conductors usually on these poles. Very few Hydro poles were lost, the interruptions to service both in the rural districts and in the urban Municipalities being due to broken conductors.

In practically all cases conductors were broken by falling tree limbs. Even lines constructed during the past summer, where trees were well trimmed, suffered severely. Some idea of the extent of the ice and snow formation may be gathered from the accompanying photographs. Evergreen trees, 30 feet tall, were bent over until their top branches were under

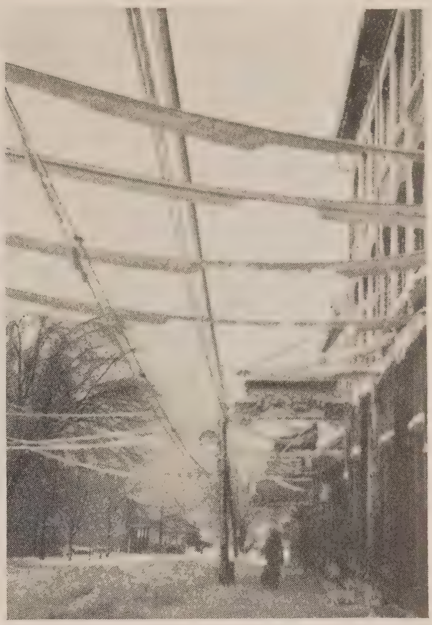
Scene north of Port Rowan showing sag in rural primary of No. 6 copper and telephone lines, produced by ice condition.

the snow drifts. Four-wire secondary buses in Port Dover and other Municipalities were totally enveloped in a solid mass of snow and ice. In one instance where a rural transformer pole fell the transformer was located with great difficulty on account of the depth of snow. In Port Dover, St. Williams, Port Rowan and other neighboring places the weight of ice and snow on the service wires pulled standpipes from the buildings.

Communication to this area was disorganized, occasional telegrams being the only means of keeping in touch with the situation. On the evening of December 19th, it was necessary to dispatch a man by radial from Simcoe to Port Dover in order to determine the extent of the damage in that Town. Travel by road was practically at a standstill for several days. Early attempts made by rural trucks, which heretofore had been able to negotiate all weathers, had to be abandoned and the use of teams and shovellers was necessary when trucks finally could be used.

Immediately following the storm it was realized that the area affected was so large that local Hydro organizations, both in the rural districts and in the Towns, could not cope with the situation ; consequently, linemen and foremen from Kitchener, Dundas, Brantford and Stoney Creek Rural offices, together with additional trucks, were moved into Welland, Haldimand and Norfolk Counties, and a supervising engineer was sent out from H.E.P.C. Toronto office. Assistance was also given to the Municipalities in the restoration of service.

Work was carried on night and day.



Scene in Port Dover showing ice and snow on street lines and services.

During daylight primaries were repaired and after dark attention was paid to secondary lines and services. As a result all lines were again in service by midnight of Christmas Eve.

The cold weather continued for a number of days after the formation of the sleet and this greatly hampered the work of pulling up slack lines and replacing broken conductors with new. Usually ice leaves the wires within a short time after a storm but, in this instance, a change in temperature sufficient to remove the ice was not experienced and occasional breaks occurred for a number of days after Christmas. These were, however, adequately handled by the local men.

From observation of conditions it was interesting to note that lines on north and south roads were subject

Damage by sleet to trees along a street in St. Williams.

to the greater damage. Another interesting fact was the behavior of tree limbs. After the storm and after the wind was reduced in velocity, tops of trees and large branches, some measuring four to six inches in diameter, continued to fall from the trees, due probably to the cold weather and to the strain placed on the limbs over the long period.

An attempt was made to determine the extent of the ice and snow formation. One sample of No. 6 hard drawn copper wire with its attached coating of ice was found to weigh a total of eight ounces per lineal foot, making approximately 6¾ ounces per foot added to the net weight of the wire. One sample of wire with the ice and snow intact measured approximately ten inches in diameter.

Weather conditions, while repairs were being made, were at times severe. On the afternoon of Friday, December 20th, the blizzard had reached such a height that men were recalled from working on the lines, as the cold was too severe and the danger too great to risk further work.

The restoration of the service in a relatively short time, considering the amount of damage done, was largely due to the loyal spirit shown by the men, and great credit is due to all who were engaged on this emergency work for the manner in which they conducted it and brought about a normal condition on the lines.

Electrical Utilities

The Crisis in Public Control

THE above is the title of a book edited by William E. Mosher and Associates of the staff of The School of Citizenship and Public Affairs, Syracuse University, (Copyright 1929 by Harper & Brothers, Publishers, New York and London). In a foreword to the volume Mr. Mosher gives the following statement as to the intention of the work, in addition to expressing recognition and appreciation to those who assisted in its preparation either by the preparation of material or by helpful comments and assistance in reviewing the manuscripts.

"Electrical Utilities, the Crisis in Public Control, is one of a series of studies of social problems prepared under the auspices of the School of Citizenship and Public Affairs of Syracuse University. It was undertaken as a staff project because, like so many social problems, it presents a variety of facets which can be adequately illuminated only through the collaboration of a number of specialists. Thus economists and engineers joined hands with political scientists, a social psychologist, a statistician and a specialist in public law.

"It is hoped that this survey of the electrical utilities may contribute to a better understanding, and possibly toward a solution, of the problem of control that is rapidly emerging as of dominating importance for the economic and social progress of the nation. In the following treatment of the subject the effort has been made to avoid dogmatic theory and prejudice and to proceed on the basis of factual and reviewable evidence."

The introduction opens with the following paragraph :—

"The electrical power industry has grown rapidly to a place of great importance in the economic and social life of the country. The full extent of its influence has not yet been felt. In many ways it bids fair to revolutionize the social and industrial conditions of our time no less profoundly than did the introduction of steam power a hundred and more years ago. It may indeed bring about more sweeping changes than those effected by the original industrial revolution, because electricity is much more easily controlled and adaptable to a wider range of uses than steam."

The remainder of the introduction and Part I, comprising six chapters, is devoted to the study of the present control of Electrical Utilities in the United States.

Part II is devoted to a consideration of various types of public control that might contribute to the solution of the problem presented in Part I. One chapter in this part entitled, "Control by League of Municipalities" is of interest since it compares operation under the Hydro-Electric Power Commission with that obtained in the United States, more particularly the State of New York. The following paragraphs have been excerpted from this chapter.

"The chapter is divided into two

parts, the first describing the organization and operation of the Ontario enterprise and the second comparing the costs to consumers and amounts of domestic consumption in Ontario and selected cities in New York State. In many ways the two areas are similar. In both are found interconnected systems covering extensive areas ; both generate electricity on a large scale, and in each the technological equipment is of the latest and best design. There are, however, so many variable factors in the two situations that valid statistical comparisons become exceedingly difficult, particularly if one aims to reach a final conclusion as to the relative efficiency of public and private management. Accordingly, it is the purpose of the second part of this chapter not to demonstrate the superiority of one type of operation over the other, but to show that in the matter of costs to consumers and amounts of domestic consumption, the Ontario system can easily hold its own with that in operation on this side of the border."

"It is believed that the method of comparing costs for identical quantities of power supplied under as nearly identical service conditions as could be specified has led to a body of data that is both fair and reliable. Consideration of these data warrants the deduction that the Ontario municipalities are on the whole enjoying more favorable rates for electrical power than selected cities in New York State which are served by private companies. This applies to all types of power with the exception of large users of electricity for commercial and industrial purposes in Buffalo and Niagara Falls, N.Y. When averages are considered there is but one exception to the above statement. This refers to the largest industrial consumer for which the average cost for the Western New York group was practically identical with the average cost of the Ontario group of cities.

"A further conclusion is that there seems to be no sound basis for the repeated contention that large industrial consumers are penalized in Ontario by subsidizing small users, at least to such an extent that the practice brings their costs above the average that is paid in New York cities.

"Finally, it has been frequently urged that the privately operated systems in Quebec are delivering power at lower figures than in Ontario. The data submitted above do not bear out this statement.

"In so far as comparative costs are an index to the managerial efficiency of an enterprise, the tables submitted above go to show that the Ontario Hydro Commission has nothing to fear from this test.

"The average cost per kilowatt-hour for domestic service is approximately 1.64 cents in Ontario, Canada, and 3.92 cents in the New York State cities, or a ratio of 1.00 to 2.39 respectively.

"These figures further justify the conclusion that domestic consumers in Ontario are being well served by the publicly owned and operated system. Additional evidence of the "service policy" of the Hydro Commission is to be found in the continuous reduction of costs per kilowatt-hour to domestic consumers.

This has resulted in a steady increase both in the number of consumers and in the average amount purchased per month, as well as in the revenues of the local electrical authority.

"In 1914, when the average cost was 4.0 cents, the average monthly consumption was 23 kilowatt-hours and the average monthly bill was 92 cents. In 1927, when the average cost was 1.6 cents the average monthly consumption was 116 kilowatt-hours and the average monthly bill was $1.87. Similar data might be presented for a number of cities. It should also be noted that the revenues from domestic service in Hamilton have increased in the years 1913-1927 from $34,452 to $608,034. In other words, the progressive policy of mass production at low unit costs and corresponding mass consumption induced by low prices seem to have justified themselves from both the economic and social points.

"The origin, character, financing and operating methods of the Ontario League of Municipalities which cooperate in the generation and distribution of electricity have been described in this chapter. The experience of the past twenty years in Ontario goes to show the feasibility of public ownership and operation along approved businesslike lines and at the same time according to high standards of public service.

"Comparisons which have been set up between representative cities prove that the Ontario consumers under the public system are faring somewhat better than New York consumers under private management The method employed was to compare monthly bills for specified quantities of a typical character rather than to compare average kilowatt-hour costs and revenues, on the ground that the latter method leads to erroneous conclusions because of many variables which cannot be eliminated through the averaging process.

"The aim of this comparison was not to demonstrate the superiority of one system over the other, but rather to show that according to the criterion of the costs of New York State cities the purchasers of electrical energy in Ontario enjoy satisfactory rates. More sweeping conclusions did not seem warranted because of the necessity of taking into account a wide range of factors and differences that do not readily lend themselves to statistical treatment. The comparisons do indicate, however, that one class of consumers in Ontario is apparently not subsidizing another class, as is so often claimed ; that is, unless a similar situation exists in the cities south of the border. They indicate further that low costs for domestic service lead to greater average consumption ; in other words that "inducement rates" bring results. Finally, the supplementary data show how low-priced electricity may be of benefit to rural and urban domestic consumers."

Hydro-Electric Progress in Canada in 1929

(Report by Dominion Water Power and Reclamation Service Department of Interior, Canada. Bulletin No. 1353).

THE steady growth of water power development witnessed throughout the Dominion during the past few years was substantially maintained during 1929 with practically every province represented in the programme of activities. This is disclosed in the following review prepared by the Dominion Water Power and Reclamation Service of the Department of the Interior.

The total capacity of new installations brought into operation during 1929 amounted to 378,400 horse power bringing the total installation for the whole Dominion to a figure of 5,727,600 horse power. There are, as well, a number of important undertakings under active construction which, according to the programme proposed, will add more than 1,600,000 horse power to this total during the next three years. In many of these undertakings an initial installation only is involved and when they are ultimately completed to their full designed capacities a further 1,500,000 horse power will be added to Canada's total. In addition, a number of important projects are under active study, some of which will undoubtedly materialize during the next few years. It is apparent therefore,that the rate of growth of recent years will not only be maintained, but will be considerably increased.

The capital expenditure involved in the development, transmission and distribution of this new power represents a very considerable proportion of the total expenditure in building construction in Canada, the 1929 outlay involving probably more than $75,000,000, while not less than $320,000,000 will likely be required to complete the undertakings planned for the next three years.

Quebec province leads in the magnitude of undertakings under way and in those completed in 1929, as has been the case during the past few years, while important developments have recently been brought into operation or are well advanced in Ontario, British Columbia, Alberta, Saskatchewan, Manitoba, New Brunswick and Nova Scotia. The principal activities in each of the provinces are briefly described in the following paragraphs.

British Columbia

With the construction actually under way in 1929 and the projects under investigation for early development, hydro-electric activity in British Columbia is the greatest in the history of the province. The largest of these activities include developments under way or in prospect by the various subsidiaries of the British Columbia Power Corporation, the West Kootenay Power and Light Company, the East Kootenay Power Company and the Powell River Company.

Among the subsidiaries of the British Columbia Power Corporation,

the Vancouver Island Power Company completed and placed in operation during 1929 a 2,000 horse power installation at its Jordan River diversion dam. This small plant known as the Diversion Power Plant is fully automatic. At the main Jordan River Power station plans have been prepared and work commenced on the installation of a fourth unit of 18,000 horse power capacity which it is expected will be in operation in 1930. The same Company has investigations under way which will be continued during 1930, in connection with the development of a large power site on the Campbell River for the supply of future power needs on Vancouver Island.

A second subsidiary, the Western Power Company of Canada, commenced active construction during March, 1929 of the initial stage of an ultimate 188,000 horse power development at Ruskin on the lower Stave River. The initial development includes the reconstruction of the Company's Stave Falls Railway; the building of a concrete dam 180 feet in height, two penstock tunnels of 21 feet in diameter and a power station to accommodate two 47,000 horse power units, one of which is to be in operation by the autumn of 1930. This power will go to increase the supply to the Vancouver district.

A third subsidiary, the Bridge River Power Company, continued construction of its undertaking on the Bridge River, the programme for which has been altered somewhat due to the placing under construction of the Ruskin development. The Bridge River tunnel is being enlarged to an inside diameter of 14 feet 3 inches and two miles have been completed. This part of the undertaking including the concrete lining is expected to be completed by July 1930. The initial development may be increased to 80,000 horse power instead of the 56,000 horse power originally planned and will come into operation in 1932. The transmission line which will carry the power to the Vancouver district will be 220,000 volts instead of the 154,000 volts as originally planned.

The West Kootenay Power and Light Company brought number three generator of its 75,000 horse power plant at South Slocan into operation in June 1929, thus completing this development. The same Company has made extensive field surveys preparatory to the early development of a 40,000 horse power plant on the Adams river from which power will be transmitted to the Company's system via the Okanagan Valley. Field surveys have also been made and plans are now being prepared looking to the utilization of the complete head available in the Pend d'Oreille River from the International Boundary to a point four miles from the mouth.

At Upper Bonnington Falls on the Kootenay River the City of Nelson added a 3,000 horse power unit to its plant during the year and at Shuswap Falls on the Shuswap River the West-Canadian Hydro-Electric Corporation brought its 3,800 horse power installation into operation during the month of June, supplying energy to the towns of Vernon, Armstrong. Enderby and Salmon Arm.

The Powell River Company has recently acquired rights on the Lois River and surveys are under way

looking to the development during 1930 of about 18,000 horse power for use in the Company's pulp and paper mill at Powell River.

Construction work has commenced on a plant on Falls River, a tributary of the Ecstall River by the Northern British Columbia Power Company. The initial installation will be 6,000 horse power and the ultimate 32,000 horse power, the power to be transmitted to Prince Rupert a distance of about fifty miles.

The East Kootenay Power Company conducted field and office investigations in connection with a proposed development of about 20,000 horse power at Phillip's Canyon on the Elk River about ten miles south of Elko. It is expected to undertake the development during 1930 and 1931.

Alberta

In Alberta the Calgary Power Company completed and brought into operation in October its 36,000 horse power development at the Ghost site on the Bow River about thirty miles west of Calgary. The Company also greatly extended its transmission systems throughout the province bringing hydro-electric energy to Wetaskiwin, Camrose, Lacombe, Cardston, Pincher Creek, Macleod, the Turner Valley and numerous smaller municipalities. An agreement was also made with the City of Edmonton for an interchange of power and a 132,000 volt transmission line will be completed early in 1930 to carry power 175 miles from the Ghost development to Edmonton.

Saskatchewan

Excellent progress was made in the construction of the first hydro-electric plant to be erected in Saskatchewan. This development which is being made by the Churchill River Power Company, a subsidiary of the Hudson Bay Mining and Smelting Company, is situated at Island Falls on the Churchill River and is designed to include six units of 14,000 horse power each, three of which will be initially installed. The plant is expected to come into operation in the Autumn of 1930 and a transmission line is under construction to convey the power to Flin Flon Mine and smelter of the Hudson Bay Mining and Smelting Company. Power will also be supplied to the mine of the Sherritt-Gordon Company at Cold Lake.

Manitoba

In Manitoba two large hydro-electric undertakings are under construction on the Winnipeg River, the first at Seven Sisters Falls by the Northwestern Power Company, a subsidiary of the Winnipeg Electric Company and the second at Slave Falls by the City of Winnipeg.

The Seven Sisters development of the Northwestern Power Company will ultimately comprise an installation of six units of 37,500 horse power each, operating under a head of 66 feet. The initial installation will consist of three units operating under a head of about 40 feet which will later be increased in two stages, first by the construction of dykes enclosing the head pond and second by the excavation of the tail race rock cut. Excellent progress in construction was made in 1929 and it is expected to bring the initial installation into

operation by July, 1931. Upon completion of this development the Winnipeg Electric Company will abandon its 37,800 horse power plant on the Pinawa channel and the whole flow of the river will be utilized at Seven Sisters.

The City of Winnipeg awarded the contract for the construction of its Slave Falls development in the month of June and the preliminary work of constructing camp buildings, trestles, cofferdams and construction plant was well advanced at the end of the year. The power station is designed to contain eight units of 12,000 horse power each, two of which will comprise the initial installation. The plant is expected to go into operation about September, 1931.

Mention should also be made of the construction of a dam at Lower Ear Falls on the English River in Ontario at the outlet of Lac Seul which will give almost complete regulation from a drainage area of 10,500 square miles and will greatly benefit the developments on the Winnipeg River in Manitoba. This dam which was commenced in 1928 was completed sufficiently early in 1929 to conserve the spring freshets. The work was carried out under the jurisdiction of the Ontario Department of Lands and Forests, the cost being shared by the Dominion and Ontario Governments.

The Manitoba Power Commission extended its transmission system by the erection of 198 miles of new lines and service was brought to the following municipalities : Cartwright, Killarney, Boissevain, Baldur, Wawanesa, Pipestone, Reston, Melita, Elkhorn and the new Provincial prison farm near Headingly.

Ontario

In Ontario installations totalling 48,750 horse power were added during 1929 while other undertakings under way will increase the province's total by 123,000 horse power during 1930. There are also other developments proposed for early commencement.

New developments completed during 1929 included the 28,200 horse power plant of the International Nickel Company of Canada at the Big Eddy dam on the Spanish River and one of the Algoma District Power Company at High Falls on the Michipicoten River with an initial installation of 11,000 horse power, the power being carried over a transmission line extending from the plant to Sault Ste. Marie. The town of Chapleau also completed a new development of 550 horse power in two units of equal capacity.

The Ontario Hydro-Electric Power Commission completed three new developments during the year, one with an installation of 2,200 horse power at Trethewey Falls on the South Muskoka River to supplement the supply to the Georgian Bay system, another at Elliott chute on the South River with an installation of 1,800 horse power to supply the Nipissing system, and a third with a 5,000 horse power installation at the power-storage dam already mentioned as having been erected at Lower Ear Falls on the English River. This latter installation will supply power to the Howey mine in the Red Lake mining district.

Owing to the rapid growth of power demand at Fort William and Port Arthur construction work being carried out by the Commission at the new 54,000 horse power development at Alexander landing on the Nipigon River was accelerated with the object of having the plant ready for operation in the autumn of 1930. Work was also advanced on the installation of a tenth unit of 58,000 horse power in the Queenston station on the Niagara River which is scheduled for completion in 1930. An additional 70,000 horse power was taken during the year by the Commission for the Niagara system and an additional 6,000 horse power for the Rideau and St. Lawrence systems under its contracts with the Gatineau Power Company. Work was also carried forward in the duplicating of the 220,000 volt transmission line to carry the Gatineau power to Toronto.

Developments in early prospect by the Commission include one of 12,000 horse power at Ragged Rapids on the Musquash River to supply the Georgian Bay system and one at Chats Falls on the Ottawa River to be jointly carried out with the Chats Falls Power Company which has a license from the Province of Quebec to develop the Quebec half of this power. The combined development is expected to have an installation of about 200,000 horse power. Additional to the Chats Falls development further power for the Commissions' future needs is to be secured from the Beauharnois Light, Heat and Power Company's development now being commenced on the St. Lawrence River in Quebec province, a contract having recently been made for 250,000 horse power, delivery to commence in 1932. A joint development at Carillon on the Ottawa River with a total capacity of about 500,000 horse power is also a future possibility.

In the Cobalt Mining district in Northern Ontario the Canada Northern Power Company commenced the construction of a 13,000 horse power development at the Lower Notch on the Montreal River. This undertaking is to be completed in 1930 and the power will go to supplement that supplied by the Company's numerous other developments.

Quebec

Over 208,000 horse power was added to the water power installation in Quebec province during 1929 while new undertakings and extensions to existing plants actually under construction will add a further 1,000,000 horse power. The 200,000 horse power placed in operation included principally the new plant of the Montreal Island Power Company on des Prairies River near Montreal and the addition of several large units to the existing stations of the Gatineau Power Company and the Shawinigan Water and Power Company.

The Gatineau Power Company, a subsidiary of the Canadian Hydro Electric Corporation, Limited, added fourth units respectively of 24,000 horse power and 34,000 horse power to its Farmers and Chelsea power stations on the Gatineau River and a 25,000 horse power unit to its Bryson plant on the Ottawa River. The Company has under construction a duplicate 220,000 volt transmission line from its Paugan development on

the Gatineau River to the Interprovincial Boundary line near Chats Falls on the Ottawa River. The Company is now supplying 182,000 horse power to the Hydro-Electric Power Commission of Ontario, 150,000 horse power of which is being transmitted over the present 220,000 volt line directly to Toronto. A new transmission line of 110,000 volts was also completed between Gatineau and Hawkesbury.

The same Company also completed the construction of a storage dam at Cabonga Lake an important upper tributary of the Gatineau River providing a reservoir with a capacity of 45 billion cubic feet. This reservoir is the property of, and is now being operated by, the Quebec Streams Commission in conjunction with the Baskatong storage above the Mercier dam, with a capacity of 100 billion cubic feet and located lower down on the same river.

Saint John River Storage Company, a subsidiary of the Gatineau Power Company, has under construction to be completed early in 1930, a storage reservoir of 3.2 billion cubic feet on Lake Temiscouata, in the Province of Quebec, to benefit the Grand Falls plant of Saint John River Power Company on the Saint John River in New Brunswick.

The Montreal Island Power Company placed in operation the 72,000 horse power initial installation of its hydro-electric plant on des Prairies River near Montreal, the ultimate capacity to be 120,000 horse power. A new feature in this plant is the adjustable blade propeller turbines operating under heads varying between 18 feet and 26 feet, the lower head reducing the present capacity to 42,000 horse power. The entire output of this plant is being taken by Montreal Light, Heat and Power Consolidated.

The Southern Canada Power Company completed and started operating a 2,000 horse power plant under a head of 175 feet on Nigger River near Ayers Cliff.

The Shawinigan Water and Power Company added a 43,000 horse power unit (No. 8) in No. 2 Shawinigan Falls plant and expects to start construction in 1930 on two additional units respectively of 25,000 horse power for the Grand Mere plant and of 30,000 horse power for La Gabelle plant both on the St. Maurice River. These extensions are being made as a result of the beneficial regulation to be afforded by the Toro rapid reservoir now under construction by the Company on the Mattawin River, an important tributary of the St. Maurice River. The reservoir which is to be the property of, and operated by, the Quebec Streams Commission will have a capacity of 33 billion cubic feet and is to be completed by the Spring of 1931.

The Shawinigan Water and Power Company also expects to commence construction in 1930 on the Upper St. Maurice development. The Company has recently completed a 220,000 volt transmission line from Shawinigan Falls to La Tuque and made important transmission extensions in the Eastern Townships.

The City of Sherbrooke completed and commenced operating a 5,800 horse power hydro-electric plant on the St. Francois River at Westbury as a part of its municipal electric system.

Other additions and extensions placed in operating during the year included 800 horse power added to Riviere-du-Loup municipal plant ; a 525 horse power plant of Chaleur Bay Power Limited near Bonaventure ; the Cie d'Electricite Rurale Ltee, 375 horse power plant near Dixville ; the St. Lawrence Paper Mills 350 horse power plant near the mouth of Grand Trinity River ; 287 horse power added to the Regent Knitting Mills at St. Jerome, and the 250 horse power plant at Temiscouata Electric Corporation on Trois Pistoles River.

At Chute-a-Caron on the Saguenay River about twenty miles below Lake St. John construction has been actively carried on throughout the year on the hydro-electric development of the Alcoa Power Company, Limited. The first stage of the development will consist of four 65,000 horse power units and orders have been placed for the machinery much of which has been installed. It is planned that the first stage will be in operation in 1931.

The Beauharnois Light, Heat and Power Company has commenced construction on a most important development on the St. Lawrence River utilizing a descent of some 80 feet between lakes St. Francis and St. Louis. The first units of the project are to be in operation supplying 200,000 horse power or possibly 350,000 horse power by October, 1932, the initial development being designed for 500,000 horse power. The proposed works include a power and ship canal approximately 15 miles in length, 3,000 feet wide and 10 to 27 feet deep ; the power station, locks and sluice gates are to be at the lower or Lake St. Louis end. It is expected that one-half of the power will be used locally and in the Montreal area, 150,000 horse power being already contracted for by Montreal Light, Heat and Power Consolidated, while the other half will go into the Province of Ontario to fulfill a contract made with the Hydro-Electric Power Commission of Ontario to supply 250,000 horse power at a rate of $15.00 per horse power per annum.

Construction operations are now well advanced on the James MacLaren Company's extensive project on Lievre River which it is expected will be completed by the Spring of 1930. The undertaking comprises a hydro-electric plant at High Falls of 90,000 horse power initial and 120,000 horse power ultimate installation, also a 250 ton pulp and paper mill and a 25 billion cubic foot storage reservoir at Cedar Rapids to be the property of, and operated by, the Quebec Streams Commission.

Preliminary construction has started for the Chats Falls Power Company which is controlled by the Royal Securities Corporation and Nesbitt, Thomson and Company, on the Quebec province side of the power development at Chats Falls on the Ottawa River. It is expected that the project will become a joint development with the Hydro-Electric Power Commission on the Ontario side raising the total initial installation to some 200,000 horse power, Quebec's portion being one-half.

Other projects under active construction include a 3,000 horse power plant by Ford Company on Ste. Anne Perade River below St. Raymond and a 500 horse power plant by the Cie

Electrique de la Baie St. Paul near the latter village on Bras Nord-Ouest River. Possible future projects, in addition to those already mentioned, include a 20,000 horse power plant for the City of Montreal under a 20-foot head using the former aqueduct canal and for which plans are being prepared.

The Quebec Streams Commission, in addition to the work already mentioned on the Gatineau, Lievre and Mattawin Rivers, has continued to encourage and enhance water power development in various sections of the province through the beneficial operation of its extensive storage reservoirs at Gouin dam and Manouan on the St. Maurice River ; Allard dam and Lake Aylmer on the St. Francois ; Taschereau dam at Lake Kenogami ; Mercier dam on the Gatineau and others on Ste. Anne de Beaupre, Mitis and North Rivers. During the past year the Commission also completed flood protection works on Desert River near Maniwaki ; studied power site possibilities on Shipshaw River and storage problems on Peribonka River, while river profile work included some of the tributaries of North River and portions of Peribonka River.

New Brunswick

In New Brunswick the St. John River Power Company completed the installation of the second and third units of 20,000 horse power each in its hydro-electric development at Grand Falls on the St. John River thus bringing the capacity to a total of 60,000 horse power. Provision is made in the plant for a fourth unit of the same capacity for future installation. Of the 60,000 horse power now installed, 20,000 horse power is transmitted to the Fraser Companies Mills at Edmunston and 40,000 horse power will supply the Dalhousie Mill of the New Brunswick International Paper Company over a transmission line 104 miles in length which, with the pulp and paper mill, is scheduled for completion before the end of 1929.

The Bathurst Power and Paper Company added a new unit of 5,500 horse power to its hydro-electric development at Great Falls on the Nipisiguit River bringing the total capacity to 14,500 horse power.

Construction activities of the New Brunswick Electric Power Commission during the year were confined to extensions of transmission lines totalling about fifty-eight miles. The Musquash hydro-electric plant of the Commission is loaded to capacity, but it is interconnected with the steam plant of the New Brunswick Power Company at St. John and the requirements of the Commission in excess of the capacity of the Musquash plant are purchased from the Company. A new 7,500 kv-a. steam turbine unit was installed by the Company in 1929 bringing its plant capacity to 12,000 kv-a.

The town of Edmunston is enlarging its hydro-electric development on the Green River by raising the dam to secure additional head and by adding a new unit of 1,050 horse power It is expected this new unit will be ready for operation in the Autumn of 1930.

Nova Scotia

The year 1929 has been the most active in the history of hydro-electric

development in Nova Scotia, particularly due to the activities of the Nova Scotia Power Commission, marking the addition to its systems of four new plants with a total installed capacity of 33,900 horse power which more than doubled the generating capacity available at the end of 1928.

The Commission completed and brought into operation on November 19th, 1929, a 3,000 horse power development at Tusket Falls on the Tusket River from which energy is being supplied to the Western Nova Scotia Electric Company and the Cosmos Imperial Mills Limited, both of Yarmouth. Storage dams were also constructed at Carleton, Great Barren and Stoney Creek Lakes which will provide about 50,000 acre feet of storage.

On the Mersey River the Commission completed three new hydro-electric developments ; the first plant at Upper Lake Falls has an installed capacity at higher heads of 7,600 horse power and the dam provides a storage capacity on Rosignol Lakes of about 512,000 acre feet ; the second plant at Lower Lake Falls has a capacity of 10,600 horse power and the third at Big Falls a capacity of 12,700 horse power. The Commission has undertaken to deliver 105,000,000 kilowatt-hours per annum at a maximum rate of 20,000 horse power to the Mersey Paper Company at Brooklyn for the supply of the Company's newly constructed pulp and paper mill.

The Avon River Power Company completed a small plant of 500 horse power capacity early in the year at Fall River for the supply of communities along the Truro road between Waverley and Brookfield. The Company also acquired the properties of the Chester Light and Power Company and completed the addition of a 368 horse power unit in the plant on the East River. A new development is under construction on the Black River where 4,500 horse power is being installed and will be tied into the Avon River system near White Rock late in 1930.

The load on the system of the Digby County Power Board has increased to a point where a new generating plant has become necessary and the Board has recently purchased the Weymouth Falls hydraulic mill of the Clyde and Sissiboo Pulp Company which it is proposed to transform into a hydro-electric plant to augment the power from the station at Sissiboo Falls.

The Slave of the Switch

Junia Finds a Modern Genii Who Comes at the Touch of a Button

DOWN through the ages the favorite fairy tale has been concerned with magic. Aladdin rubbed his lamp and lo his slave appeared and granted all his wishes. Midas had only to touch in order to create gold past the dreams of avarice. Fairies gave to mortals a Wish, or even Three Wishes, and the moment they had spoken a desire, it was theirs. Magic response, instantaneous results, instead of long and laborious effort, such is the favorite dream of mankind. Now, it seems to be a fact that men must dream for ages before their dreams find expression in reality. Men talked of flying for centuries before they found wings. They made stories of magic and at last the magic came true through such inventions as telephones and electricity.

Now all over the world the story of the magic touch is coming true. There is white magic caught in all the waterfalls and held prisoners for ages until at last the genius of man released it. This magic is not the slave of one man but of all mankind, and at last it is true that by simply pressing a button we may have wonderful gifts. How wonderful we forget if we do not sometimes stop to remember the days before the Slave of the Switch came to dwell among us. On a sunny day in August we went exploring among the fertile fields of Oxford County and we came home more firmly convinced than ever that Electricity is the answer to every dream of magic and that there is no place on earth where the Slave of the Switch can do more for its master than on a farm.

When we called on Mrs. B. L. Siple at Currie's Crosing, we found her still using an electric range installed in 1923. She is an enthusiast on the subject and declares that in addition to the great saving of labor, there is a distinct improvement in the cooking when it is done by the even, controlled heat of electric power. There is no burning of food by a sudden flare-up, nor is there the old spoiling that meant that the heat had died down while one turned one's back. No wonder the housewife rejoices in the clean and shining servant that offers a variety of heats to suit every purpose. Mr. Siple contributed a heartfelt comment on the subject of the freedom of the menfolks from the burden of carrying wood on busy days.

As Mrs. Siple said, here are all the comforts of town with the delights of the country. In the living-room the radio is run by electricity ; there are lights and pretty lamps in all the rooms ; the laundry in the basement is no longer a place of back-breaking drudgery ; and now everyone is talking refrigeration. That is the next gift the farm women are asking of the Magician of the Switch.

At City View Stock Farm, one of the establishments run by J. W. Innes & Sons, we found that the pump is the valued servant. As we drove up to

In the living room of a farm home in Oxford County.

the house, we could hear the cheery humming of the motor which runs about half of every day, pumping water from a three-hundred-foot well to supply from one hundred to one hundred and fifty head of stock as well as putting water on tap in the house and barns. This was one of the very first farms in the district to put in electricity, and after sixteen years they have nothing but praise for this faithful servant. Mr. Innes echoed all other users of Hydro when he declared that it had been no trouble to wire the house (all new houses should be wired in the building), and they found that about five hundred dollars took care of all the expense of installation. "There is no other way in which we could get the same comfort and help at any cost," said Mrs. Innes, "we could not think of doing without it now. At first years ago we thought we could not afford it, but we soon found we could not afford to do without it."

On this farm the automatic pump is the most valued servant, since a supply of water is a first essential on a stock farm, but there are endless ways in which the Electric Servant is a dutiful slave. The separator alone is worth the cost of the system on such a farm and in the house the washing machine, the iron, the vacuum cleaner, the lights, the electric fireplace, all make a list of comforts that mean much to this progressive family.

Travelling up hill and down through the pleasant land of Oxford, we saw many homes where they have summoned the Hydro servant, for this County is one of the leaders in the use of Hydro on the farms. At Spruce Dale Farm, near Woodstock, we found Mrs. C. H. Jackson full of praise for the wonderful service

enjoyed during the two years since they instaled electricity. The turn of the switch gives fuel to the stove, power to the washer, heat to the iron, lights everywhere in house and barn, and heats water for the bath. "How the men do appreciate the hot bath these threshing days," said Mrs. Jackson.

One of the first things we noticed on the farm of E. Harwood, near Woodstock, was the tennis court with a large electric light at one side. That means that tennis does not have to stop because the sun goes down, and it seems to give the note for the place that Hydro plays on this farm, where a real enthusiast has turned his ingenuity to use in an almost magical way. There are lights everywhere in house, barn and yard. The washer and iron in the house are as good as any laundress and better than most, in simplifying wash day tasks. Mr. Harwood's motto is put Hydro to work and get the worth of your money. He has certainly lived up to it. In his work shop he put belts on a dozen wheels and Junia turned one switch. Instantly the place was humming with energy, the grindstone whirling, the chopper cutting, the emery wheel buzzing, the milking machine in action. Mr. Harwood has figured that the work done by Hydro more than repays the eighty dollars a year it costs, and that the lights and conveniences in the house are free.

In Woodstock we called on H. R. Vigar, Superintendent of the Rural Power District, to collect some of those facts and figures that give point to the story of this modern Genii. There are in the district over 300 farms using Hydro, and it is interesting to note that most of them want an electric iron first of all. Many have ranges, and those who haven't get a hot plate for convenience until the range can be afforded. There are twenty-five electric radios in the district, while many are interested in iceless refrigeration, and it seems likely that before long a number of these will be installed.

Cost is one of the big problems to prospective users, yet it would seem that cost is not a factor after all. The testimony of the up and coming farmer is that Hydro pays for itself in comfort and saving of labor.

On these busy farms where they run pumps and machines and household appliances and radios they find the yearly cost about eighty or ninety dollars. Installation costs a few hundred dollars. That is for the price of one small machine or a used car one can summon a faithful servant who will never give notice, never slack, and who will add immeasurably to the comfort and well being of the farm home.

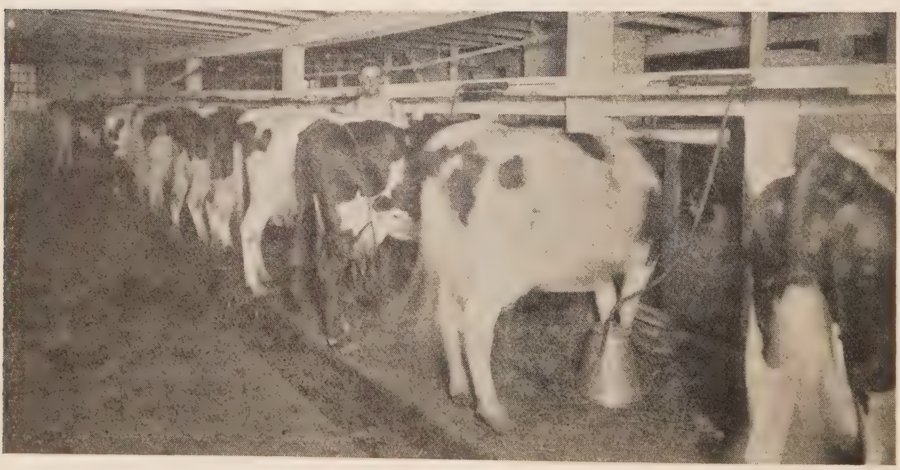
—*The Farmers' Advocate.*

Reduction in Rural Rates

COMMENCING January 1, 1930, reductions in rural rates will go into effect which should very materially affect the demand for electric service in new districts.

Under the present system of rates the ordinary farmer, known as a Class 3 service, has a maximum service charge of $4.10 per month, while under the revised basis of rates the maximum service charge to this consumer will be $2.50 per month and other farm classes will be reduced in about the same proportion. There are a number of districts in which the service charge to a Class 3 consumer at the present time is less than $2.50, but there are a great many districts, especially in new territory, where the maximum rate must be used. This reduction in service charge to a maximum of $2.50 per month is being made at the request of the Government, and the difference in revenue will be provided by the Government so that the rural power districts will not be operated at a loss.

The Commission is instituting a very active educational campaign to show the farmer the various ways in which the electric service can be used on the farm to the farmer's financial advantage. Experimental work is being carried on at the present time in connection with the development of a small chopper, using 2 or 3 horse power, which will satisfactorily grind grain. Nearly all farmers require to grind a considerable amount of grain during the year and the fact that a small efficient grain chopper is available should assist very greatly in making electric power attractive to the farmer.



Milking time on an Ontario farm.

Light in Dark Corners

Light is penetrating many of Ontario's dark corners, the light that comes from the white water of our rivers and streams. This Summer has seen the extension of hydro lines to about 9,000 more farms, which brings the total rural users up to 36,000. The day when the Ontario farmer will no longer work two or three hours night and morning by lantern light in the winter months, is steadily approaching. Recently we visited a farm in Waterloo county on the evening that the Hydro was first installed. His enthusiasm and that of his family in the change it made in their surroundings was "electric" in more ways than one. No more will he carry a lantern hooked over one arm as he travels the feed walk. No more will the boys guess at the feed they give the calf in the far pen. Nor will they stumble over the steps when they enter the root cellar or the silo. They have light wherever they go about the farmstead. In the house an even greater change is noticeable. Those cellar stairs no longer will be negotiated in semi-twilight, with a lamp in one hand and a basket of provisions in the other; no more smoky chimneys to wash or dirty wicks to trim. Labor savers will be installed shortly to further ease the burden. But light and more light through the long winter evenings carries the first and greatest appeal, and even thought of the added expense fails to dim that first enthusiasm. Light means more to the rural home than an easier method of doing the work. It is a distinct advance in the farmer's standard of living, as exemplified in the comfort and well-being of his family.—*The Ontario Farmer.*

From *The Delta Star* we get the following paragraphs published under the caption "Years Ago."

From *London Electrician* June, 1908.

The dense fog, or rather darkness, which enveloped London last Wednesday caused many anxious moments to the engineers of the electricity supply companies. That the occurrence was of exceptional character may be gathered from the fact that the load on the Charing Cross Company increased by no less than 8,000 h.p. in 25 minutes. Great credit is due the company for taking care of this emergency and not allowing the voltage to fall below its normal value.

From *London Electrician*, November, 1907.

A hot controversy is raging between the gas and electric lighting interests. Professor Vivian Lewes claims that the products of combustion from gas fumes in a room, are carried upwards by the heated air and diffused through the plaster ceiling above, with the result that the atmosphere of the room is much more healthful than it would be if electric light and no gas were used. His opponents wanted to know what happened to the occupants of the floor above.

Electric Light "A Failure Fifty Years Ago To-day"

JUST why we are not a nation of blind men, just why we have not all been electrocuted, and just why we are idiotic enough to continue to use such a "conspicuous failure as the electric light," are questions which might cause great consternation in the minds of a great many minions of the "scientific" press of half a century ago, if they saw fit to recall a wealth of statements which greeted its introduction at that time.

"Would it not be as well," said the *New York Times* of Nov. 13, 1879—a month less than fifty years ago—"to invent some mode of abolishing night altogether ! A dozen artificial moons would answer the purpose." . . . The connection between moonlight and the lunacy of successful electric light seems to have been popular, for in a letter to the *New York Herald*, on New Year's Day of 1880, we find Henry A. Mott, Jr., Ph.D., concluding a list of ten objections which made the electric light of doubtful value with the following : "It is claimed that the penetrating power of the electric light affects the nervous system, as the light is similar to moonlight." . . .

According to the *New York Telegram* of Aug. 16, 1881, "people obliged to work continuously by this light are having their eyes gradually destroyed thereby." And the president of a prominent technical school assures the world that "everyone acquainted with the subject will recognize it as a conspicuous failure."

The power plant problems of the day were also dragged into the conflict. First of all, according to the manager of a gas works who was defending his own business to the death, it was uneconomical. Speaking of a test of arc lights, he said, "It was found that there was a constantly varying power in the light, at one time rising as high as 1,500 and then falling to 300 candle power. To run two of these lights for twelve hours required 12 h.p. taken from the engine, and involving (sic) an expenditure of 2,000 lbs. of coal." High speeds just ended the whole thing ; for, according to this letter to the *New York Herald* of Dec. 25, 1879, "the engine we use on our exhausters is usually run at 25 r.p.m., but when employed in connection with the electric machine, 900 r.p.m. is required which involves a good deal of wear and tear on the machinery."

Edison had a display at the Paris Electrical Exhibition in the autumn of 1891, and he had a "big boiler, a big engine, and a great number of separate lamps." Quoting from the Journal of Gas Lighting, the *Scientific American Supplement* of Oct. 8, 1881, says : "First, we find him using a boiler of 150 h.p. ; then a steam engine of 125 h.p. of Armington's make. This transfers a speed of 360 r.p.m. to the armature of a dynamo-electric machine. This armature weighs more than 3½ tons. It is drawn across the lines of force of a magnetic field ; which magnetic field is produced by three electromagnets

converging at their points. These electromagnets are not in the general circuit. The duty of the armature is 120 h.p. according to the statements made ; that is to say, 96 per cent. of the work done on the machine appears as the energy of an effective current of electricity. This installation, the entire weight of which amounts to 30 tons, is to keep aglow 1,000 Edison incandescent burners. But this is much cry for little wool. The lamps are unanimously said to give not more than 16 candlelight each, the usual run being about 10 or 12. Suppose it be 12, 1,000 such lamps burning for an hour give 12,000 candlelight. The engine has been passing, according to the statement approved by the parties interested, 120 h.p. of work into the wire, in the shape of electricity. That is to say, the effective result is 100 to 130 candles per horse power—a deplorable loss of light. A thousand rushlights would look brilliant, and no doubt the 1,000 incandescent burners will produce a fine display ; but when we think of the 150 h.p. boiler and the 125 h.p. engine, any tendency which might be felt to rush away and invest money in Edison's incandescent burners may be modified and sobered down, if not obliterated."

Problems of distribution were also featured in the news. Says a gas manufacturer in an interview with a *New York Herald* reporter : "The trouble about household lighting by electricity would be in regulating the supply for each dwelling. The house nearest to the place where the electric machine might be stationed would have the advantage of houses farther away." . . .

The maze of load-factor considerations came into play in 1880, it seems, and *Engineering* says : "It will require something more than mere words before we are found converted to the creed that when electricity is used to run motors for sewing machines, the amount of power used in the daytime will 'largely pay for the expenses of generating, an additional advantage over gas.' We might as well be told that the consumption of gas in the summer will 'largely pay' for generating gas in the winter"—*Power.*

Look Them Over

In the morning when first you go on the job lay your tools out in front of you and LOOK THEM OVER. Maybe your hammer or chisels have mushroom heads — perhaps your wrench is sprung—possibly the handles of your screw drivers and files are missing or loose.

These defects and others that may cause accidents can always be discovered if you consider it a part of the day's work to LOOK THEM OVER.

Do you use ladders ? If you do, LOOK THEM OVER. A weak or broken rung may cause a nasty fall. Bad sides often cause ladders to collapse. The absence of safety feet suitable for the floor on which a ladder is to be used may be responsible for its slipping. If you want to use ladders with safety get the LOOK THEM OVER habit.

How about the machines you run? Do you keep them clean ? Are they properly oiled ? Are the belts correctly adjusted ? Are all guards in

place? To avoid accidents on machines always LOOK THEM OVER before you put them in operation.

LOOK THEM OVER, the boxes and barrels, the trucks and conveyors, the floors and the benches, the stairs and the platforms—and, if you see any conditions likely to cause injuries, call them to the attention of your foreman or a member of the Safety Committee.

If you are an honest-to-goodness Safety Scout, one of your guiding mottoes will be LOOK THEM OVER.

—*National Safety Council,*
P. U. News Letter

The Insulating Value of Wood

A recent report of the N.E.L.A. covers a series of tests on hot line tools and switch sticks, showing that specially seasoned, standard equipment of this nature is safe for use on energized conductors, but that ordinary seasoned wood, as carried in the lumber yards, is not safe.

The hot line sticks tested were of specially seasoned hardwood, coated with clear or orange shellac cut with denatured alcohol.

Several of these sticks were given a potential of 50 kv. over a 10 inch section with no visible sign of leakage or failure. Some of them showed meagre readings to infinity until the electrodes were brought very close together.

On the other hand, in similar tests, oak and yellow pine purchased at a local lumber yard, treated with shellac in the same manner, failed when subjected to the same test. One oak stick became warm when 50 kv. was applied for five minutes on a 20 inch section. When connections were changed to a 15 inch section it broke down in less than two minutes. A yellow pine stick showed about the same results. The breakdown was internal, the arc breaking through from the inside to the surface. The shellac surface coating did not break down. A standard switch stick shellacked withstood 50 kv. for 25 minutes with electrodes 7 inches apart. There was no sign of failure.

The result of these tests indicates that standard switch sticks and hot sticks purchased from a reliable concern, made of highly seasoned hardwood with special consideration for their use as insulation against high voltages, are safe if kept dry, clean and well protected with shellac, and that any other wood may be dangerous on high voltages.

Unless it is a matter of life or death—a case where the risk of life to save life is justified, do not handle conductors energized at transmission line voltages (10,000 and upward) with any stick or wood handled tool except those made expressly for this purpose.—*The Au Sable News.*

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

Hydro News Items

Central Ontario System

On January 6th the municipalities of Brighton, Port Hope and Napanee voted to purchase their distribution systems and enter into a cost contract with this Commission.

* * * *

The villages of Stirling and Madoc, who have been receiving power at fixed rate for some years, also voted in favour of entering into a cost contract with the Commission. These villages have always owned their own distribution systems.

* * * *

The cities of Oshawa and Belleville which have already purchased their distribution systems from the Commission, elected their Hydro-Electric Commissions at the January elections. Mr. C. T. Barnes and Mr. O. H. Scott will continue as Hydro managers in these cities.

* * * *

A 12-mile extension to the Peterboro Rural Power District has just been completed to serve the village of Keene and surrounding rural district. This extension is a three-phase, four-wire system operated at 8,000 volts. The Peterboro Rural District is distinguished by having the lowest service charge in the Province, principally due to the fact that the district handles a large power load in addition to the ordinary rural load.

* * * *

Georgian Bay System

Instructions issued during the past month for rural construction in the Georgian Bay District cover a total of 16 miles of line to give service to 103 consumers.

* * * *

Niagara System

A 300 kv-a. transformer has been installed at Caledonia to carry the increasing rural load in the Caledonia R.P.D.

* * * *

A duplicate circuit is being installed between St. Catharines and Port Dalhousie in order to handle the load in the latter municipality.

* * * *

The electrification of the pumping station of the Michigan Central Railroad at Cayuga will result in 50 horse power being taken from the Haldimand R.P.D.

* * * *

During the month of December, 1929, instructions were issued for the construction of approximately 95 miles of rural line in the Niagara District. The extensions involved will serve about 235 rural consumers.

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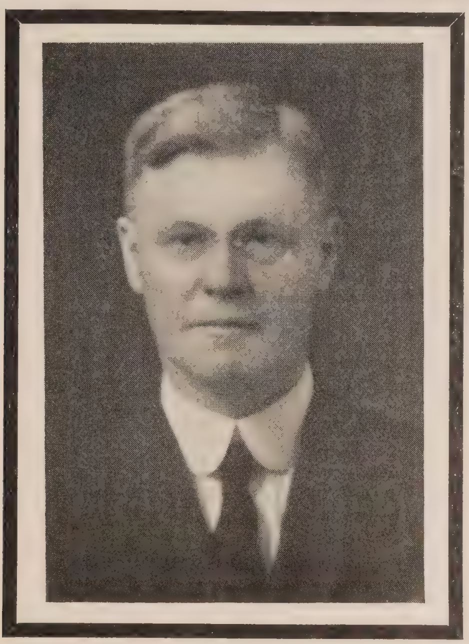
THE
BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year



Robert Campbell McCollum

IT is with sincere regret that we record the passing of Robert Campbell McCollum at his home 209 Parkside Drive, Toronto, on the evening of Wednesday, February 19th, 1930.

Although Mr. McCollum's health has not been of the best for the past few years, yet he has carried on his duties almost continuously until two weeks before his death. Even then his condition was not considered to be serious as he was at the office for a short time on the preceding Thursday afternoon, and he was looking forward to his permanent return to the office in a very few days.

Mr. McCollum's early life was

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spent near Brampton, Ontario, where his father, Robert McCollum, had a Coal and Wood business. After completing his education at Brampton he entered the employ of the Erie Railway Company where he rose to the position of Chief Clerk. Later he joined the staff of the Fairbanks Steel Shovel Company, Marion, Ohio, as Secretary-Treasurer. In May, 1912, he joined the staff of the Hydro-Electric Power Commission of Ontario when the office of Municipal Auditor was created and has since been in charge of this work.

Wherever "Mac" has gone he has always made friends. Not only has this been within the staff of the Commission, where he was universally known and respected, but also in all of the offices of the Municipal Utilities where his duties took him.

Mr. McCollum is survived by his widow, Rose Culp McCollum, a daughter, Mrs. C. W. Richardson, two brothers and two sisters, to all of whom we extend our heartfelt sympathy.

In Memory of ROBERT CAMPBELL McCOLLUM

He was a little kinder, he was a little blinder,
To the faults of those about him, and he praised a little more;
He was often tired and weary, but always bright and cheery;
He served a little better those he was striving for;
He was a little braver, when temptation bid him waver;
He strove a little harder to be all he tried to be;
He was a little meeker with the brother who was weaker;
He thought more about his neighbour than he did of Robert C.

—S. J. Millikin, Midland.

Employee Relations

By J. H. Brace, General Manager, Western Division, Bell Telephone Co. of Canada

(Address to Association of Municipal Utilities at Toronto, January 29, 1929.)

IN addressing a group of men engaged in the work of a great Public Utility I feel that I am at home among you since your problems with respect to employee relations have much in common with those of my own Company.

Furnishing a public service to a community involves the use of men and materials. Without doubt, the most important factor in establishing and maintaining a good and economical service is the type of employee and his relation to the organization of which he is a part.

So when I was asked to speak to you on "handling men" it seemed to me that this could best be done by drawing to your attention some of those things which we, in the Company I represent, find important in our relations with employees. Many of these things are obvious—yet is it not true that it is too often the obvious things which are overlooked.

Selection

In our Company we believe that a good employment organization is fundamental to our success with employee relations and that too much care, in the beginning, cannot be given to the selection of the proper man to head up the employment service. We look upon this man as occupying a key position.

Through our employment organization we have built up specifications for the various vocational groups of employees and have determined the physical, mental and educational requirements for each group. This involves a medical examination as well as an intelligence test on the part of all applicants for positions. By these methods we endeavor to eliminate, as far as humanly possible, those who do not appear to have the necessary qualifications for our work. The rejection of these people, at the outset, reflects a definite saving in the future operation of our business.

Training

The matter of training separates itself into three distinct classes, namely, training of the vocational employee, training of the foreman, and training of training-instructors.

Vocational Employees

The training of vocational employees is covered partly in the classroom and partly on the job, that portion in classroom being under the direction of specialists on specific subjects, whereas the training on the job is recognized as part of the definite responsibilities of the foreman. It is recognized, of course, that some foremen have more ability than others in developing men under their direction.

Classroom instruction is given not only to new employees but also to the older employees when their day by day work indicates that this is desirable or when new methods or

new pieces of apparatus are developed for use in our business.

In general, we recognize that the best training is obtained on the job, particularly if the foreman realizes his responsibility and is competent to give such training, since the training so given is not subjected to any time limit and embodies the problems encountered in the day by day job instead of, as is met with in class room the installation of plant and equipment only faintly resembling that found on our thoroughfares or in our subscribers' premises.

However, classroom work has its definite place in our training program and makes possible very rapid training on major functions of our work at comparatively little expense, with the consequent possibility of a new employee being able to get on a production basis quite early during his career with us.

We have also for all vocational employees, or for anyone who wishes to take advantage of it, an out of hour course on a correspondence school basis covering instruction in Mathematics, Electricity and Telephony.

Foremen

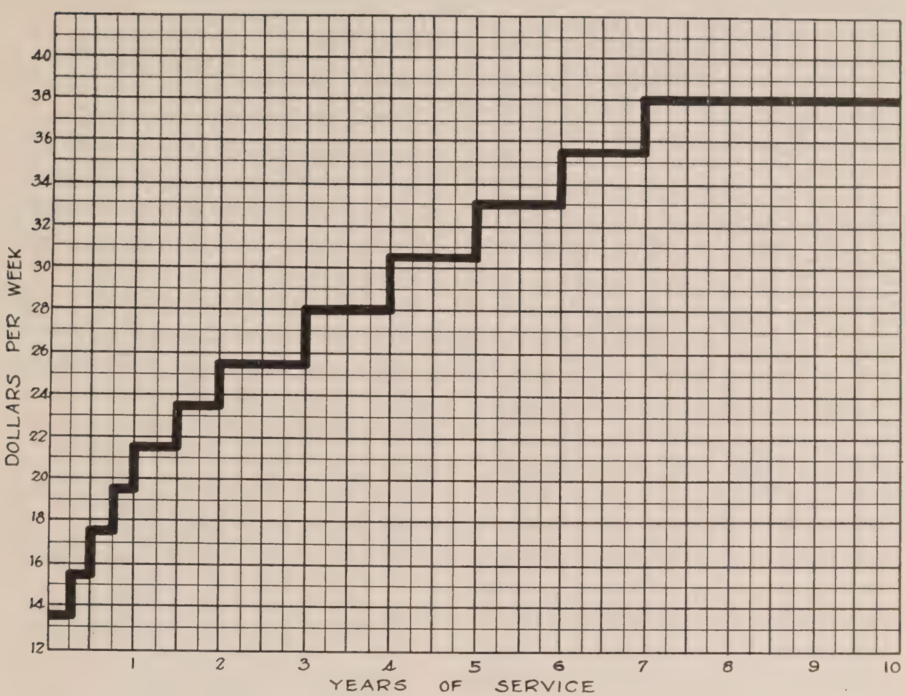
With respect to the training of foremen two practices have been adopted and both are being used in our program for developing these men. We have, first, the vocational course of instruction for foremen which is carried out under the direction of a training instructor and which covers a period of about one month. This has been made applicable, during the past year, particularly to foremen on construction work where it has been necessary to very extensively augment our forces on account of our construction activities having been very largely increased.

With this method, six to eight foremen, or linemen in the course of development to take the position of foremen, are placed under the direction of a foreman instructor who, through classroom work and work on the job, develops them in handling men, planning and executing the job, accident prevention, accounting routines and in fact all matters having reference to their work.

A specific piece of construction work is given to this group to handle, they are furnished with a truck and all the necessary materials and spend a portion of each day on the job constructing the work in hand. Each day, one of the men in the class acts as foreman on the job, the remainder working under his direction as linemen, the instructor being with them at all times. The classroom work consists of a review of the day's operations, suggestions from all concerned as to how such operations might better have been performed, and a definite planning of the operations for the succeeding day. All reports which normally are prepared with respect to the use of material, payroll forms, etc., are made out by the man who acted as foreman and are checked by the instructor and the remainder of the group.

Our experience with concentrated training of this nature, covering a period of a month, has been that we have been able to develop foremen competent to furnish a satisfactory performance when placed upon their own responsibility, even though such men have had as little as two years'

TYPICAL WAGE SCHEDULE



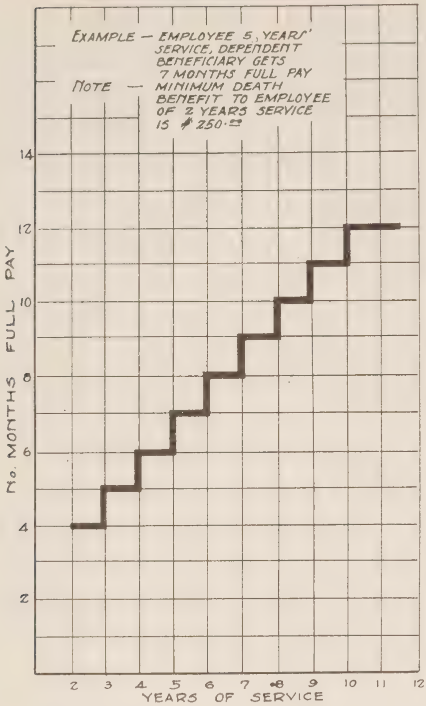
experience with us as linemen. Naturally, the results obtained are, to a very large extent, dependent upon the selection of the men from the ranks to be given this course.

The other course of training for foremen is what we describe as our "Foremen's Conference" where for two weeks twelve instructors, under the direction of a Conference Leader, carry on discussions in a round table conference covering all phases of those problems of concern to them. These men are selected, somewhat indiscriminately, from the engineering, construction, installation and maintenance supervisory forces, and the subjects under discussion bring out different points of view and contribute materially to the educational value of such conference.

In our Plant Department every senior supervisor from the Division Plant Superintendent down has taken this course during the past two years and the course is still being carried on with the new supervisors who have been appointed during recent months. We plan to have a follow-up conference of a somewhat similar nature with the supervisors who have already taken this course, the follow-up conference, however, being of a somewhat shorter duration.

The course has, undoubtedly, been of particular value in developing the foremen, in getting them to think more for themselves rather than to follow routines blindly or, as so frequently happens, neglect to take the full responsibility for their position,

SICKNESS DEATH BENEFITS TO DEPENDENT BENEFICIARY



looking for direction from their immediate supervisor at every turn.

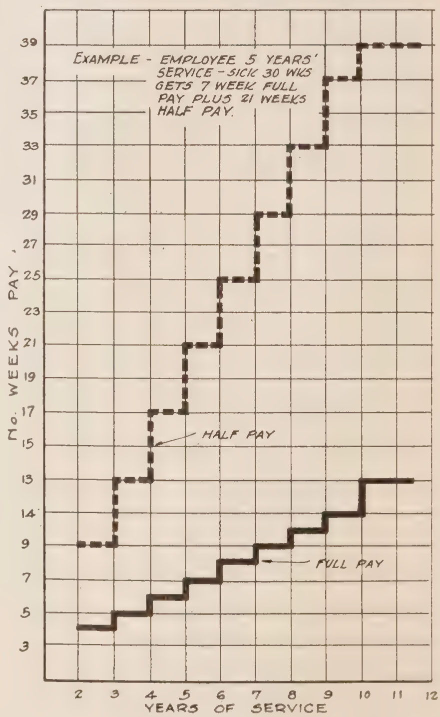
Training-Instructors

The third training program to which I referred has to do with a special course developed for so-called training-instructors. This course, carried on under the direction of our employment organization and covering a period of about six weeks, is set up with the idea of developing the art of imparting knowledge, or of making teachers of men who already have the necessary experience but have not developed to the maximum their ability to instruct.

In this instance it is particularly important to make a careful selection of the human material to receive such instructions. Those men who, without special training, have proven themselves to be outstanding in their ability to impart knowledge and to develop men are, insofar as possible, selected for this work, and the course of instruction which is largely of a classroom nature has been set up to develop to the greatest possible extent the ability of these men to impart knowledge and to train others.

So far, these instructors have largely been used for the training of foremen, but, to some extent already and it is expected to a greater extent in the future, they will take their positions in the field as foremen and the inexperienced men, particularly those with promise for further development, will be placed under their

SICKNESS DISABILITY BENEFIT



direction so that they may obtain the maximum amount of training that we can give.

Separation From The Force

Irrespective of the diligence of those responsible for the selection of new employees, some misfits do get into the organization. We consider it a definite responsibility of the foremen to see that these people are separated from the force within the first two years of employment. This is only fair to the individual himself, to his fellow employees, and to the Company. Unquestionably, if a "Lame duck" is retained in the organization for from five to eight years, the Company has a definite responsibility toward him and is probably faced with carrying him along in some capacity for the remaining years of his life.

Wage Schedules and Working Conditions

There is much more to employee relations than the selection, training and the elimination of the unfit. Frequently, the difference between success and failure is dependent upon the extra effort, the enthusiasm and the loyalty that the employees give to their work. Insofar as possible we should develop self-confidence, self-reliance, freedom from worry, greater satisfaction in life and efficiency in work, greater value to one's family and increased esteem in the community. All these things return real dividends to a company, and particularly to a public utility.

The wage schedules for our vocational employees are designed so that the maximum rate is reached in about six or seven years, starting with a rate sufficiently attractive to obtain the type of man required for the particular vocation and locality. Increases during the first year or two, are given at frequent intervals, later, the length of time is extended and the amount of increase raised.

The top rate should not be outstandlingly high as compared with other industries but should be well up around the top. We want, not only to secure the better types of employees, but we desire to keep them contented with their chosen vocations.

The cost of living in the locality concerned, the wages paid in other industries, and the class of work performed by the particular group of employees, primarily determine the maximum rate paid.

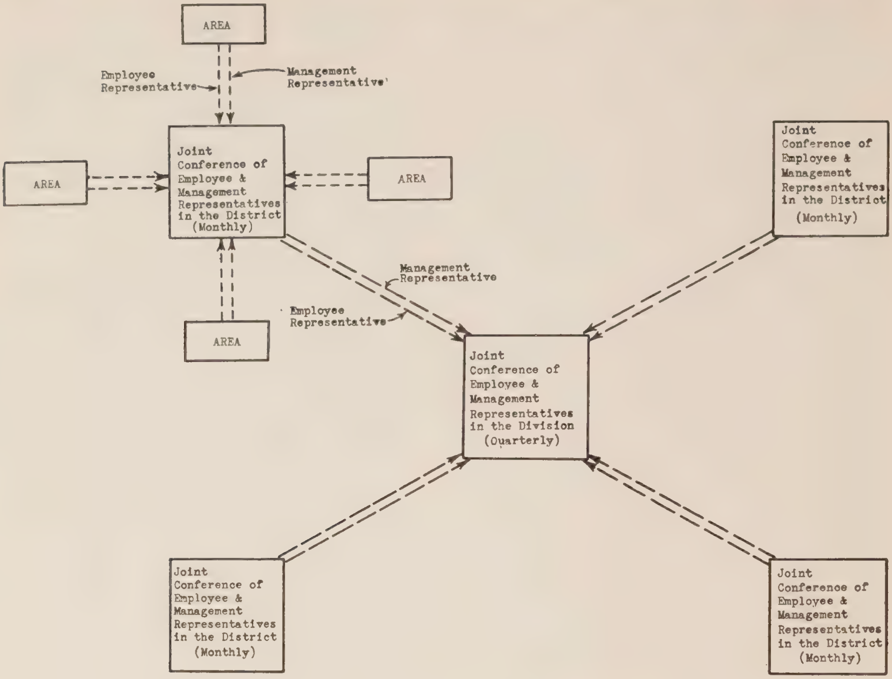
The employee representatives, through our Employee Representation Plan which will be explained later, have a definite share in setting up these wage schedules, but in this joint effort, Management relinquishes none of its responsibilities.

The following are some of the more important policies of our Company in its relations with the employee body :

1. We endeavor to provide steady and permanent employment for those who have proven themselves competent workmen.

2. We make every effort to provide safe methods for carrying on the work and we furnish the employees with safe tools. Instruction in "First Aid" is recognized as an essential among male vocational employees and the majority of them are qualified First Aiders.

3. We provide overtime payment



JOINT CONFERENCE COMMITTEE ORGANIZATION

DISTRICT & DIVISION

for legal holidays, and vacation payments in accordance with the more liberal practices of comparable industries in our territory.

4. We attempt to obtain efficiency in operation not through overworking the employees but rather through development of the most effective practices, carried out with wise and careful planning on the part of Management.

5. We make provision, through our Benefit Plan, for payments to employees when sickness or other misfortune comes their way.

6. We have a Pension Plan which supplements the savings of the individual and permits him to enjoy some of the comforts of life when he retires.

7. Our Stock Purchase Plan enables employees of more than six months service to purchase stock, the amount being dependent upon the salary of the particular individual. Such purchases are made on the salary deduction plan and extend over a period of about three years for a particular subscription.

8. We have arranged with two of our large Canadian Insurance Companies to make salary deductions on a monthly basis for the payment of insurance premiums. Standard insurance policies are issued, and our experience, over a little more than two years, indicates the desirability of this feature from a thrift standpoint as well as from the standpoint of protection to the employee's family. Undoubtedly, many men disregard

their responsibility in providing adequate life insurance.

9. Direct relations between Management and vocational forces, are established by means of and through a Plan of Enployee Representation. Under this plan, which was set up with the mutual approval of all parties, round table conferences are held at stated intervals, between the elected representatives of the employee groups and the management. At these conferences there is discussion in a fair, open way of wages, working conditions, Company policies, methods, materials, Company activities, in short anything and everything pertinent to the proper carrying out of the job, which is to deliver to the public the best possible telephone service.

The above, outlines, in general, the major factors with respect to the Company's policy and its relation to the employee. Fundamentally, of course, our relationship is based upon the acknowledgement of fair and just treatment of the employee. We cannot afford to say one thing to them and act differently. We could not justify taking advantage of periods when unemployment is on the increase in other industries to reduce wages in our own industry. We could not afford to take advantage of any legislation which would act temporarily to the advantage of the employer and to the disadvantage of the employee.

Summing up the situation, our relations are built upon fair play, no extravagance in wages or other payments to the employees, but at all times a strict adherence to the "Golden Rule". Our experience has indicated that the loyalty, enthusiasm and goodwill developed through the entire employee body more than justifies the policies which are now firmly established and which we have no thought of discontinuing.

Discussion

Mr. Wills Maclachlan, H.E.P.C. of Ont : Mr. Chairman, I think Mr. Brace has most thoroughly covered the situation, and it would appear that those who have charge of large organizations are feeling more and more the necessity of going into, in a practical way, the different contacts between employer and employee. I think those with larger organizations would do well, particularly, to follow out the idea of the plan put forward by Mr. Brace. Such a plan might not apply in some of the smaller organizations, but it most certainly does in the larger. Those organizations like the International Harvester Company and some others on the other side of the line went into this about twelve years ago. You will find that most of them went in after careful consideration and are now extending and making those plans more effective. The careful selection of your men and training them in the different details of your work, as outlined by Mr. Brace, is most effective, and it most certainly should receive serious consideration. The matter has been so ably set before us that there is nothing I can add.

Presentation of Resuscitation Medals

MR. S. W. Brown, Manager of Service Department, Canadian Westinghouse Company, Hamilton, Ont., acting as representative of Mr. P. S. Gregory, President of Canadian Electrical Association, presented two Canadian Electrical Association Resuscitation Medals at the Convention dinner on the evening of January 29th.

These medals are awarded in meritorious cases of resuscitation from electrical shock by employees of public utilities in Canada. The metal used in manufacturing the medal is from the first High Tension Transmission line in the British Empire, namely that from St. Narcisse to Three Rivers, Que., put into operation in 1895.

Samuel Staines

On July 3rd, 1929, an employee in one of the substations of Toronto Hydro-Electric System, climbed on top of a live transformer instead of a dead transformer, to carry out a cleaning operation and came in contact with 13,200 volts causing him to fall, rendering him unconscious and not breathing. Mr. Albert Barnetson, an employee of the Toronto Hydro-Electric System, immediately went to his assistance and by carrying out the Schafer Prone Pressure Method of Resuscitation was able to resuscitate him.

Albert Barnetson

On November 15th, 1929, an employee of the Canadian Westinghouse Company while operating an electric drill inside a condenser at Leaside Station, received a shock of 110 volts. He was rendered unconscious and was not breathing. Fellow employees with considerable difficulty got him out of the condenser and Mr. S. Staines, Operator on duty at Leaside Station was called to the

accident and immediately started the Schafer Prone Pressure Method of Resuscitation. By carrying out this he was able to resuscitate the victim of the accident.

These two men by foresight and by being able in an emergency to carry out their training in resuscitation, were able to be the instruments of returning life but what for their action would have passed out.

Testing and Research in H.E.P.C of Ont. and Its Relation to the Municipalities

By W. P. Dobson, Chief Testing Engineer, H.E.P.C. of Ont.

(*Read before the Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Toronto, January 30, 1930.*)

THE Association of Municipal Electrical Utilities at its Winter Convention in January 1929, passed the following Resolution :—

"That the Hydro-Electric Power Commission of Ontario be requested to submit a report at the next meeting of the Association showing the extent to which it is possible to extend the work of testing and research in the Commission's Laboratories."

The passing of this Resolution is an indication of interest on the part of the Municipalities in the work of the Commission's Testing and Research Department and of a desire to become more fully acquainted with this work.

Several years have passed since the last discussion of laboratory work was held by this Association, and I shall therefore sketch briefly the recent history of the department and its present activities, before dealing with the resolution which is the reason for this paper.

The first steps towards the organization of a testing department were taken three years after the Commission began to deliver power. Previous to that time the necessary inspection and testing were carried on by the various engineering divisions. In 1913 a building was erected on Strachan Avenue to house the laboratory, storehouse and machine shop ; the laboratory occupied about 7,500 sq. ft. of the space and employed a staff of seven.

In 1917-18 the building was enlarged to three times its former size and at the present time the laboratory occupies the whole of the original building with a floor space of approximately 21,000 sq. ft.

About the year 1917, there began a period of rapid expansion in the Commission which was reflected in the growth of the Testing and Research Department. A rough idea of the material growth of the department since then may be obtained by comparing the statistics of that time with those of the present. In 1917 the capital invested in the laboratory was $46,000 and in 1919, after the

enlargement of space, $136,000. It is now $195,000. During the same period the number of employees has increased from 48 to 64. The cost of operation in 1929 was $158,000. The investment in the laboratory equipment is now about 1/10 per cent. of the total investment of the Commission and the municipalities.

Description of Work Now Carried On By The Testing and Inspection Department

Functions

The functions of the department, as is well-known, are testing, inspection and research. These functions have been within recent years more clearly defined, and the relation of the department to the rest of the Commission more clearly understood, with the result that its value to the Commission has increased and its importance has been appreciated and recognized.

The functions of the department involve work both in the laboratories and outside. These two phases are supplementary to one another and each is necessary. The field work furnishes a fund of experience to the laboratory staff and enables it to keep abreast with the progress of the Commission and fully informed as to the engineering and scientific problems which are met with in the operation of the systems.

Approval Testing

One activity of the department will not be stressed in this discussion since it deals more particularly with the public. This is the approval testing which the Commission carries on as agent of the government in connection with its work of electrical inspection of installations. This work has been described before the Association and the only mention which appears necessary at this time is a brief statement of the progress made since its inception in 1918. The work entails the preparation of specifications governing test and approval of electrical equipment, the laboratory testing of this equipment, factory inspection of the product and involves the closest co-operation and contact between the laboratory staff and the electrical industry in all its branches. The staff in this section of the laboratory is now 17. Its ramifications lead it to all parts of the country and to many parts of the United States. Factory inspectors go out to approximately 57 cities in Canada and 81 cities in the United States and inspect the factories of 716 manufacturers. The approval of the Commission with respect to electrical appliances is recognized all over the country and this is written into the Canadian Electrical Code as the necessary qualification for the approval of apparatus.

Laboratory and Field Testing

Returning to the functions of the department let us consider first materials and equipment. The Commission has adopted the policy that in general all material and equipment shall be purchased under specification, and this involves both laboratory and factory tests to determine whether the specifications have been complied with. These tests may be electrical, physical or chemical, and may range from a determination of the microscopic structure of a piece

of steel forming part of a forging to efficiency tests on a completely assembled generator of 50,000 kw. capacity. The whole range of the properties of materials is covered and knowledge of a special character is required in order to solve many difficult problems which arise in determining the quality of materials or the efficiency of equipment.

Inspection

Closely allied with the work of testing is that of inspection which may be distinguished from testing by defining it as an examination, usually visual, of the component parts of machines or structures in order to discover mechanical faults detectable in this way and to compare the dimensions of these parts with those required by the plans. This is not an accurate description of the difference since inspection frequently involves testing and the two are complimentary to one another. It is necessary for our purpose however to make a distinction in order to give you a clear explanation of the activities of the department. The following examples will illustrate what I mean by inspection.

The construction of transmission lines involves the design of towers, their fabrication in the shop and erection in the field. The first step is taken by the Engineering Department the second by the manufacturer, and the third by the Construction Department. The responsibility of the laboratory begins at the factory stage. Let us take as example the inspection of steel towers and follow the inspector through the various stages of his work. His duty in the shop is to examine each part as fabricated and to compare it with the blueprints supplied to him by the Engineering Department, to make examinations and tests for defective material and for protective coatings such as galvanizing. It may be necessary for him at times to call upon the laboratory for tests upon the material, which he is unable to make in the shop. He must be sure that each tower is shipped complete and it is also his duty to assist the Engineering Department in the securing of prompt delivery of its orders. The failure of the inspector to detect a mistake in the dimensions of a single piece might result in the enforced idleness of a number of men while the defective part was being replaced from the factory.

As a second example of major activity in inspection, I shall take concrete. Beginning with the Queenston - Chippawa development, the Commission undertook a systematic plan of inspection, having in view improvements in methods of proportioning concrete and in obtaining structures of sufficient strength and durability. As a result of the success attained in this work during the Chippawa development it has been continued and is now on a permanent basis. The procedure for concrete inspection is as follows :

When a new development has been decided upon, the laboratory is instructed to survey the available deposits of sand and gravel in the neighborhood of the work and to recommend a suitable source of supply. This involves inspection of deposits, the collection of samples, and preliminary laboratory tests to

determine the suitability of the materials. When a satisfactory source has been decided upon, preliminary proportions are set by laboratory tests, and when construction work has begun an inspector trained in the methods of concrete inspection in the laboratories, is stationed on the job where he reports to the resident engineer and is responsible for the quality of the concrete poured. If necessary by reasons of location, he is furnished with testing equipment. Samples are taken periodically from the mix and formed into test cylinders and after a suitable period of storage they are broken in compression and the results taken as an indication of the strength of the concrete. Variations in the quality of materials or in conditions of temperature etc., obtaining during the construction work are allowed for, and in this way the quality of the concrete is under continuous control in so far as is humanly possible.

But inspection does not cease when the structure has been built. The investment of the Commission in concrete is so great that it is considered necessary to make a periodic inspection of its structures. This is done by the laboratory experts and it has been of value in many ways. It has enabled us to detect signs of deterioration before they would otherwise be observed ; it has furnished information regarding the weathering and other qualities of concrete which has been of great value in revising and improving our methods of control as applied to work now in progress ; it has also furnished information of great assistance in the prosecution of research in concrete, which will be referred to later.

It should be stated in passing that this concrete work of the Commission is probably the largest single example of laboratory methods applied to the placing of concrete in the field, and the results have amply justified the experiment. The Commission has been the subject of praise from concrete authorities all over the world as a result of this work.

Another example of laboratory control of material, which is of interest to all Hydro line workers, may be found in rubber gloves.

This very necessary adjunct to the lineman's equipment is responsible for much thought and care on the part of the laboratory. Since the lineman's life depends upon the condition of his gloves it is essential that he be furnished with the best obtainable and that they be maintained in perfect condition. The Accident Prevention Department and the laboratories have prepared specifications governing the purchase of gloves and have established a complete routine including periodic testing and inspection, which is designed to accomplish these desirable objects.

Insulating oil is one of the most important materials used by the Commission, and furnishes another example of laboratory control. Many thousands of gallons are in use, and it is essential that accurate knowledge of its condition be available at all times since the appearance of an infinitesimal quantity of impurities will quickly and materially lower its protective value. This knowledge is obtained by periodic tests in the

laboratory and in the field. This has enabled us to detect signs of deterioration and has assisted us materially in our researches on the properties of insulating oils, so it is evident again that inspection and research are closely related and are complementary to one another.

The examples I have given were chosen to illustrate the complete system of control which has been applied to some materials. This is the ideal which we should like to attain for all materials, but it has not as yet been possible to reach it.

As an example of partial control we may choose paint. For the past twelve years we have been accumulating information by test and research about the properties required of paint for various uses, and the characteristics of paints on the market. A procedure governing the purchase of paint has been adapted and it has proved valuable in securing improvement in quality. The inspection of paint in service, however, has not yet been placed on a systematic basis. We are with the co-operation of the Operating Department gradually extending our observations in the field and correlating them with our laboratory tests.

Related Activities

The work which I have been describing involves closely related activities which are not strictly speaking testing or inspection. In the preparation of specifications the question of materials and their properties often arise, and the assistance of the laboratory is frequently invoked by the Engineering Departments in order that specifications may reflect the latest practice and most up-to-date knowledge in this respect.

In order that the laboratory may be posted in these matters its members must have special knowledge. This is obtained either by research work and study or by contact with other engineers engaged in similar work. The most satisfactory way of obtaining progress is by membership on standardizing and other technical committees. The laboratory is represented on Committees of such bodies as American Society for Testing Materials, the Canadian Engineering Standards Association, The American Institute of Electrical Engineers, National Research Council, American Concrete Institute and others. Of these the American Society for Testing Materials devotes its attention especially to the preparation of standard methods of testing and it is on committees of this organization that we are most active. This work involves very often special testing and investigations in co-operation with other laboratories throughout the United States and Canada.

Objects of Testing and Inspection

From the preceding description of the functions of the laboratories in testing and inspection, it may be inferred that this work is considered of importance in the operations of the Commission. The purpose of this control over materials and equipment may be stated in brief to be :

1. To ensure good quality in materials purchased and to determine whether the equipment purchased is in accordance with the specifications of the Commission ;

in other words, this is supplementary to the work of the Engineering Department in design and it is considered as necessary as that work since the designer in his calculation presupposes that good materials and equipment will be supplied and if there is no means of ascertaining this he must work with higher factors of safety than may be necessary.

2. To ascertain the quality of materials and equipment in service in order that evidences of deterioration may be detected in time to prevent disaster or that some assurance may be obtained of continuous good quality in materials and equipment. This has an important financial bearing since it may result in a lower rate of depreciation than would otherwise occur and may permit a smaller sinking fund. This feature of the work is exemplified in periodic tests of transformer oil and rubber gloves, periodic inspection of concrete structures, in the investigation of paints and protective coatings, etc.

Research

The third main function of the department is research and here it is necessary to define just what this term means in so far as it is applied to our activities. Research is a much abused term ; it originally applied to the academic investigations of scientific workers and it received great impetus during the war when scientific knowledge became a most pressing need in assisting the military forces to combat the enemy. Since that time research has been promoted in all countries of the world—governments, universities and industries. The term has been seized upon to describe activities remotely connected with scientific investigations. We now hear such terms as commercial research, personnel research, marketing research and so on *ad inf.* This abuse of the term has somewhat detracted from the dignity of the original conception and has perhaps lost sympathy for research in the minds of some people.

Speaking of scientific research, there are two main divisions : The first is fundamental research in science which aims at the discovery of the laws which govern the forces of nature and their operation. The physicist investigating the structure of matter, the chemist studying the properties of the elements are fundamental research workers.

The second main division of research is that which makes use of the discoveries of the physicist and chemist to assist mankind in controlling and applying the forces of nature for his own purposes. The chemist who produces a new compound, the engineer who designs a new type of electrical machine and who studies the electrical phenomena in transmission lines, are workers in this field. It may be designated as industrial research, and although this term is not satisfactory, it is probably sufficiently descriptive for our purpose.

Engineering Research

Coming to the field of research in which we are particularly interested ; that is, electrical engineering, we may divide it roughly into the following divisions :

1. Research dealing with power production.
2. Research dealing with distribution and utilization.

The first division in this classification has to do with equipment. It is essentially a manufacturer's problem since the manufacturer must design and construct equipment. Research in this field, as now conducted by manufacturers, is extremely broad in its scope and many manufacturing companies have established research laboratories in which fundamental research in physics and chemistry is carried on as well as investigations of problems arising in the design and construction of apparatus. This policy has produced wonderful results and the organizations which are following it have through their research workers made many contributions to pure science in addition to the commercial developments from which they have materially profited.

Manufacturers' research deals with properties of materials which come into the assembly of machines, processes of manufacture, electrical phenomena in machines, methods of design and a host of other problems.

I am here devoting special attention to electrical machinery. The machinery used by Power Companies is, however, not entirely electrical. The manufacturers of turbines, governors, valves and all accessory mechanical equipment concerned in power production are as vitally interested in research as are electrical manufacturers and their problems cover a field probably as great as that of the latter.

I shall return to the discussion of this division of research later, but shall say in passing that the power companies are interested in research of this class to a certain extent. The manufacturer is dependent upon the power companies for information regarding the operation of his equipment, and it is therefore of interest to the power company to study the characteristics of machines and the properties of materials as they are effected by the conditions to which they are subjected in operation.

The second division of research as applied to electrical engineering deals with transmission, distribution and utilization. This also includes equipment and to this extent it is a manufacturer's problem. Transformers, circuit breakers, disconnecting switches, lightning arresters, transmission line insulators, conductors, towers, underground cables, regulators, and all accessory equipment involved in distribution systems form elements with which research in this field is concerned.

I spoke a few moments ago of the interest the power companies should have in electrical equipment and research. This interest is based upon the desire that equipment should function satisfactorily, that is, it should resist successfully all the conditions, electrical and mechanical, to which it may be subjected in service.

The determination of these operating conditions, constitutes an immense field of research. The first and foremost is electrical phenomena in transmission lines and terminal apparatus. This is a subject on which much work has been accomplished but it has not yet been exhausted.

The electrical phenomena within conductors and apparatus under normal steady operating conditions are now fairly well understood by engineers and are subject to calculation. Unfortunately however conditions do not remain steady and changes in load, short circuits, grounds, lightning disturbances all introduce conditions which may be called abnormal and which impose additional strain upon the electrical system. These phenomena are comprised within the term "transient", and a study of transient conditions on transmission systems is yet in its infancy and the methods of solution are for the most part "cut and try."

This subject is of intense interest both to the utility and to the manufacturer—to the manufacturer because he needs the information in order to design equipment to withstand the conditions or to protect the system from the effects of these conditions ; to the utility because of the extreme importance of this knowledge in the operation of power systems.

For many years the manufacturers took the lead also in this field, but within recent years a change has been taking place in the attitude of the power companies towards research. They are entering fields which formerly were left to the manufacturers and are co-operating closely with them in the solution of common problems. As an example of this may be cited cable research. This problem was very forcibly presented to the utilities located in large cities where large increases in loads within limited areas made necessary an increase in voltage for underground cables greatly beyond those then existing. This demand was sudden and imposed upon manufacturers and power companies a severe task. The research which became necessary was undertaken initially by the manufacturers and later by manufacturers, universities and power companies in co-operation and considerable progress has been and is being made as evidenced by the successful production and operation of 132,000 volt cables.

Closely connected with this problem and more fundamental is that of insulation. This is the most important problem now facing the industry and probably that upon which future progress largely depends. The discovery of the laws governing materials under electrical stress, the production of new insulating materials, the nature of electrical breakdown are some of the problems being attacked by workers in this field.

Lightning has always been the "bug bear" of electrical power systems and while electrical engineers have striven for years to combat its effects, it cannot be said they have been completely successful. The essential information, namely, the nature of lightning and the characteristics of lightning discharges have until only recent years been a closed book. With the development of new methods of measuring extremely short time intervals great inroads have been made upon this problem within the last year or two. The cathode ray oscillograph and the lightning generator appear to be the tools which will enable us to fashion the solution.

The problems I have just mentioned are receiving vastly more attention on the part of the power

companies at the present time than was devoted to them a few years ago. The large utilities now realize that they have a responsibility as well as a selfish interest in these matters; their solution is of direct interest to them in their work of supplying electricity and for their own protection they must be armed with accurate knowledge of electrical phenomena and of the behaviour of materials under operating conditions. The responsibility falls upon the whole industry to advance the art and each section of the industry must be willing and prepared to do its share in this work.

The municipalities of the Commission have a direct interest in all of this, since the quality of the equipment supplied to them and the uninterrupted supply of power both depend upon the satisfactory solution of these problems. They share in the beneficial results of this research.

The Research Work of The Commission

With this introduction to the research problem we are in a position to understand the Commission's interest in research and what it is now doing.

In the first place it may be stated that the Commission does no fundamental research in physics and chemistry, nor has it been active in research on equipment for power production since it is not its function to manufacture equipment; this is primarily the manufacturers' problem. Its chief activities in the electrical field have dealt with problems of plant design and construction and with operating problems. Referring specifically to electrical research the phenomena connected with high tension transmission lines under transient conditions such as short circuits, grounds, switching operation and their effect on equipment have been at various times investigated. The characteristics of new types of equipment as effected by line conditions have also received attention and within recent times the study of lightning upon our lines has received attention, but this has not been carried out to the degree of completeness desired because of the lack of the newest types of measuring equipment referred to above. This work on lightning has been carried on largely on the 220 kv. system of the Commission within the last year and a half and has yielded important information regarding the magnitude and extent of lightning disturbances. The extension of this research is now under consideration.

The Commission is also interested in non-electrical research and has carried out a systematic program of concrete research to which reference was made above. This research dealt at its inception with methods of proportioning concrete materials and important economies were effected as a result of the investigations. This has been continued on a systematic plan. Durability of concrete, economics of concrete and allied subjects have received attention, and a fund of information has been accumulated which is probably equal to that of any organization in the world. Numerous papers have been prepared by members of the laboratory staff and have been published in many different languages. The great value of this work has been in the correlation of the

laboratory work with field methods and in the systematic plan of following concrete through from its placing in the forms to its condition years after installation.

The Value of Testing and Research Work

It will be evident from the preceding discussion that the research activities of the Commission are confined to problems of an extremely practical nature. They are suggested in part by our experience in testing and inspection and in part by the desire of the engineering and operating departments to improve methods of construction and operation. It will also be evident that this work touches all the technical departments of the Commission, and it is therefore extremely important that it be continued and extended. Its value to the Commission lies in its assistance towards the obtaining of a well built and efficient plant and the successful operation of this plant. It is also of importance to the Commission in protecting its investment. How does the Commission protect its investment ? Firstly, by securing the best equipment obtainable and materials of guaranteed and proven quality ; secondly, by maintaining this equipment in good condition, thirdly, by providing a fund for the replacement of the equipment when it has worn out or become obsolete. In the first two, the activities of the laboratory and research department play an important role. The beneficial results are not evident to the public but that they exist there can be no doubt. They are evident in our daily experience.

Its value to the municipalities is indirect but none the less important since improvements in equipment and in materials are reflected in the quality of the service rendered to them. It is of value to the manufacturers in assisting them to improve their product. And all of the improvements achieved are passed along to the public, our common beneficiary.

This discussion has formed an introduction to the answer I now give to the question asked by your Association ; namely, How can this work be extended ? The answer is twofold :

1. It may be continued on a larger scale than heretofore.
2. It may be enlarged to embrace fields not now covered.

In order to continue the work on a larger scale, the co-operation of the municipalities is necessary. The commission is enlarging the work in proportion to its growth and is prepared to expand it for the benefit of the municipalities. It can be extended if the municipalities will make use of the facilities which are available in the department. These are of two kinds which may be described as tangible and intangible, the tangible being the special equipment available and the intangible, the special training of the personnel which enables the department to render a service which is not necessarily better than but different from that rendered by other departments.

An adequate discussion of the possibilities of extending our research activities into new fields is not possible in the time available. The general directions, however, may be indicated.

Mention has been made of the fields of research now opening up to the utilities and of the Commission's interest in these fields. We shall undoubtedly make progress in these directions.

The municipalities, however, are primarily interested in the distribution of power to the public and in the revenue accruing therefrom. Consequently, they should be interested in means of improving the efficiency of distribution, and in methods of utilizing electricity which will increase its benefits to and its use by the public.

These, briefly, are the spheres in which it appears that our work may be extended.

The Hydro-Electric undertaking is an outstanding example of co-operative effort. Modern industrial research is also predominantly co-operative. There exists therefore in the Commission one of the elements essential to success in research. If the problems of the Commission and the municipalities are approached in this spirit the results will, I have no fear, justify the efforts and the research activities of the Commission will become of increasing importance.

The Commission has considered the resolution and has authorized me to say that it fully appreciates the importance of the testing and research work now being carried on and the necessity of extending it. It invites the complete co-operation of the municipalities and will give full consideration to the suggestions which they may make.

Discussion

Mr. E. V. Buchanan, London: As I was responsible for making the motion that is referred to in the opening paragraph of this paper, a year ago, I think perhaps I ought to open the discussion. Might I say at the outset that we are greatly indebted to Mr. Dobson for a paper of this kind. I would also like to say that I think the Commission is very fortunate in having a man like Mr. Dobson in charge of the laboratories. Mr. Dobson's work has been recognized not only all over Canada, but all over the world. What I had in mind in making this resolution a year ago was that we were piling up in the majority of Municipalities, large surpluses in spite of the low rates for power and light, and that, in the interests of National economy it was not advisable to reduce these rates further. The better methods of generation, transmission, distribution and application, resulting in higher efficiencies, are quite equivalent to lower rates from the standpoint of the consumer, and yet not wasteful as would be the case by simply reducing the rates.

When I brought this matter up a year ago, Commissioner Maguire seemed to resent somewhat the idea of such a resolution. He seemed to think it was a criticism of the work of the Commission. He stated the Commission was doing a great deal of work in this connection, and that he had not heard of any need for more work along these lines. There was no criticism of the work of the Commission implied whatsoever, and most

of us, I think, realized that a great amount of valuable work was being done. I did, however, point out to him that while a great amount of work was being done along the lines of generation and transmission, work in connection with distribution and application was being almost entirely neglected. To demonstrate this point I came across in this week's *Electrical World*, an editorial which I would like to read to you. It is entitled, "Straining at a Gnat and Swallowing a Camel". "Not many utility executives and engineers are willing to admit that their engineering expense for generation and transmission is all out of proportion, considering the ratio of generation and transmission losses to distribution losses. Distribution losses are in round numbers 70 per cent. of total system losses, yet utilities will spend perhaps three times as much for transmission and generation engineering as they do on distribution. They fight for the last quarter of one per cent. in efficiency of generators, high-tension transformers and transmission lines, and seem to forget that a gain of the same fractional percentage in efficiency in distribution is relatively more than twice as important. When it is considered that 30 per cent. of the energy generated never finds its way to the consumer's meter, and that 70 per cent. of this loss occurs in the distribution system, it is clear that the distribution system has been neglected. If some of the high-priced skill that has been brought to bear on the 30 per cent. end of the losses were swung over to the 70 per cent. end, would there not be more hope of getting somewhere ? Have not the utilities been straining at a gnat and swallowing a camel ? Why not have a searching analysis of distribution losses, and some real concentration on the distribution end of the business?"

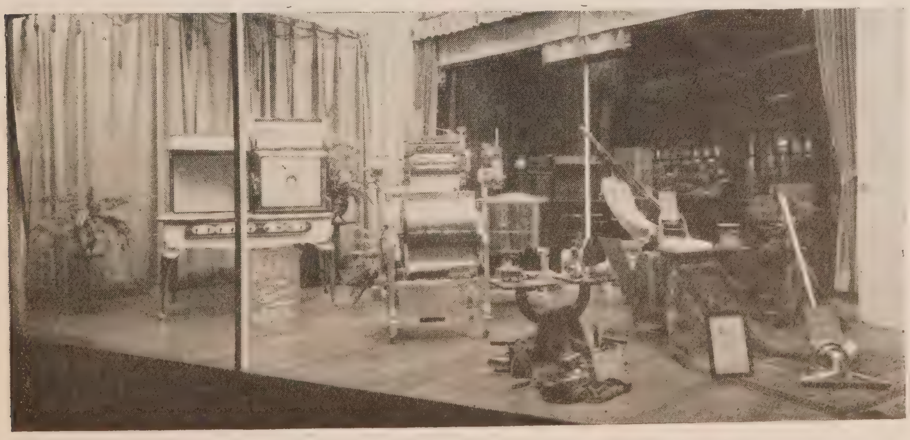
That, I think, seems to express my ideas on the matter very aptly. We have been doing a little in that respect but it is surprising how great these distribution losses are. Some four or five years ago we discovered that our distribution losses were 19 per cent., and by the small amount of engineering work we have been able to do, we have now reduced those losses to eleven per cent. In London, one per cent. represents $6,500.00 a year, so that by that small amount of work we have saved $50,000.00 annually. A great deal more could be done along these lines. Take, for instance, the remarks made yesterday about the exciting current of transformers. When I made this resolution a year ago I was not quibbling about any definitions of the word "research". I was thinking more of the matter of research and testing and, in fact, all technical matters which were outside of those incidental to operation and management.

It occurred to me, when Mr. Dobson was speaking of approval testing, that the men who are engaged in the approval of apparatus might very well extend their work to suggestions as to how such appliances could be made more efficient. Take the electric cooking range. I believe the Canadian electric range, as made by Canadian manufacturers, is as good a range as made anywhere in the world; in fact, I think better, but, after all, gentlemen, we must admit that the electric range of today is still a very

primitive piece of apparatus. Then, there is the question of water heaters. Water heaters as installed now are, on the average, only fifty per cent. efficient. The water heating load is somewhat frowned on by many of the Local Managers and, if it is only going to be fifty per cent. efficient, perhaps they are right : but why can't there be a vast improvement in the matter of electrical water heating ? We pick up magazines and we read everywhere of investigations being made into this subject. Why couldn't the Hydro Power Commission correlate and collect all the data connected with this matter ?

Mr. Dobson spoke of co-operation between the Municipalities and the Commission, and I would like to emphasize that matter as much as possible. I think we should all try to co-operate with the Commission and avail ourselves of their services. Take, for instance, the question of paint, mentioned here this morning. How many of you have ever asked the Hydro Power Commission any advice or assistance in the matter of selecting paint ? Or have you simply bought your paint because the salesman showed you a paint that was a nice bright red ? It is very wasteful for every Municipality to do all its own investigating along the lines I have mentioned, and the co-operation I am suggesting would be of much greater benefit if it could be done centrally.

Another matter. Except perhaps where a problem was very specific as to location, most of this work could be done for the Municipalities out of the general funds, no direct charge being made to the Municipality requesting the work ; much in the same way as the lighting service which is now rendered by Mr. George Cousins, of the laboratory staff, is being done. I don't think it would be too much if Mr. Dobson's appropriation were increased ten times its present amount and even at that it would only amount to some 5 or 6 per cent. of our total revenue. I think it would yield wonderful dividends, and I would like to see a start made, in some constructive way, by the formation of a Committee of this Association to work in conjunction with the Commission in the matter of testing and research.



Distribution Transformers and Connections

By Joseph Showalter, Canadian Westinghouse Company, Limited, Toronto

(Read before Association of Municipal Electrical Utilities at Toronto, January 29, 1930)

THE transformer is the keystone of the modern electric power industry. It is the foundation upon which rests the whole alternating current system of transmission and distribution of electric energy.

That plain unattractive piece of apparatus is responsible for the ample and uniformly inexpensive supply of electric energy to the homes and industries of our cities, towns, villages, and even rural communities, almost regardless of location, relative to power development.

The efforts of the scientist and engineer have given us the highly efficient and reliable transformer we have to-day, but in principle and appearance it differs little from the world's first transformer built by Gaulard and Gibbs in 1882, which turned the whole electric power industry from direct to alternating current.

There are two main groups of transformers : Those used to step up generator voltage to transmission line voltage and those used to step transmission line voltage down to distribution line voltage are called power transformers. These are usually made in sizes greater than 200 kv-a.

Transformers used on distribution systems to supply secondary voltage suitable for consumers' services are known as distribution or service transformers and are made in sizes from three to two hundred kv-a.

As the members of this Association are more interested in the latter group, this paper will give more attention to distribution transformers than to power transformers.

It might be advisable to define some of the terms used in reference to transformer practice.

Polarity is the time phase relation between the primary and secondary leads. If the primary and secondary leads on one side of a transformer are joined and a voltage applied to the primary winding, a voltmeter reading taken from the free secondary lead and the primary lead on the same side will indicate the polarity. If the voltmeter reading is less than the voltage impressed upon the primary winding, the polarity is subtractive. If it is greater, the polarity is additive. Power transformers are usually supplied with subtractive polarity, while distribution transformers are made with additive polarity.

Iron Loss is the energy required to magnetize the iron circuit. In distribution transformers it is practically the same as the no load loss. It is almost the same under all load conditions. The iron loss is expressed in watts at the rated voltage.

Hysterisis Loss is the power consumed to alternately magnetize and demagnetize the iron. It varies with

the quality of the iron and affects the iron loss and exciting current.

Magnetizing Current is the out-of-phase or wattless current that flows in the primary of a transformer when the secondary is open.

Exciting Current is the resultant of the iron loss and the magnetizing current. It is the amperes flowing in the primary of a transformer at rated voltage with the secondaries open. It is expressed in per cent. of the full load current.

Impedance is the resultant of the resistance and reactance of the windings. It is found by measuring the voltage required to circulate full load current at rated frequency through one winding with the other short-circuited and is expressed in the per cent. of the rated voltage.

Regulation of a constant potential transformer is the difference between the no-load and the rated load values of the secondary terminal voltage, expressed in percent. of rated secondary voltage, with the primary impressed terminal voltage adjusted to such a value that the transformer delivers rated kv-a. output at specified power factor and rated secondary voltage. (A.I.E.E. definition.)

Efficiency of a transformer is the ratio of energy output to energy input. The losses represent the difference.

Temperature Rise is the rise in temperature over the surrounding air, under full load conditions. In Canadian specifications for distribution transformers, 50° Centigrade is given as the limit for the temperature rise. In the United States it is 55° C. It refers to the rise in temperature of the copper in the coils and is found by measuring the rise in resistance of the windings.

Taps in standard distributon transformers are leads brought out at other points than the ends of the windings in the primary coils. They are used to change the ratio and maintain secondary voltage with reduced primary voltage. The use of taps reduces the capacity of a transformer because a greater amount of current must flow in the primary winding in proportion to the load on the secondary.

Standard taps are approximately 4½, 9 and 13½ per cent. They usually represent reduced voltage values in round figures. A 2300 volt transformer would have three taps for reduced voltages of 2200, 2100 and 2000.

In 1920 the Sub-Committee on transformers of the Canadian Engineering Standards Association issued a report which attempted to standardize single-phase transformer requirements. This report recommended standards in kv-a. rating, primary and secondary voltage rating, polarity, tap percentages, and some details of construction and performance. The kv-a. size ratings recommended have become standard, also polarity and tap values, but there is little uniformity in voltage ratings. Transformers are ordered and supplied with primary voltage ratings of 2200, 2300 and 2400 volts, also an assortment of higher values.

It should be possible in the 2200, 2300, 2400 volt class, the class almost universal on our urban systems, to compromise on the 2300 volt rating, making it standard for all systems of this class.

If a check were taken on our distribution systems, it would likely be found that 2300 volts comes very near to the average primary voltage found in practice.

Transformers supplied now have a much better performance on small voltage variations than those made some years ago, especially in the matter of exciting current. A transformer designed to operate on 2300 volts primary and used on 2200 volts would have a slightly lower exciting current and iron loss, and the copper loss would increase a little. At full load the total losses would be very slightly greater with a slight reduction in efficiency. These variations are very small, less than the actual difference in performance of individual transformers on the same voltage. The 2300 volt transformer operated on 2400 volts would have a slightly higher iron loss and exciting current and a lower copper loss. The efficiency would be improved slightly. The variation in efficiency on primary voltages of these values in more recently made transformers is very small, in both instances amounting to about one-third of one per cent. at full load, and less at lower loads.

The members of this Association would do well to bring about a standard rating of 2300/230-115 volts for distribution transformers.

The successful operation of transformers depends as much upon the care with which they are stored, installed and maintained as upon the design and manufacture.

Most distribution transformers are shipped in their tanks without oil. Power transformers are shipped in oil. The reason for this is that the complete winding and assembly of distribution transformers is impregnated with an insulating compound to keep out moisture. This treatment is not ordinarily given to power transformers. For this reason distribution transformers suffer little from the common practice of storage in the open air exposed to rain and weather. When a transformer or drum of oil is taken from a cold to a warm location it should be allowed to reach the temperature of the warm location before being opened, as otherwise moisture will condense on it and ultimately get into the oil.

Before a transformer is filled with oil it should be carefully looked into for evidence of moisture. If any moisture is present the transformer should be dried out first, then filled with dry oil to the level indicated in the tank.

When a hose is used to convey oil it should be metal instead of rubber. The oil dissolves the sulphur in the rubber which may attack the copper in the windings.

Pole mounting transformers may be filled with oil either before or after mounting on the pole, as desired. It is important that the oil, when cold, should reach the oil level indicated in the tank. When the transformer becomes hot the oil will rise above this level.

Care should be used in replacing the cover to see that the gasket is properly in place so that the driven rain or snow will not find its way into the transformer. After installation, within a few days, the transformer should be inspected to see that it has not been over-heated and the oil remains up to the level indicated.

Sometimes air is trapped in the transformer core and windings when the transformer is filled with oil and is liberated when the oil begins to circulate, lowering the oil level. When this has occurred, oil should be added to bring it up to the right level. This inspection should be repeated every year and oil added if necessary. Every three years the oil should be removed from the tank, if sludge has precipitated, as much of it as possible should be rinsed out with this oil, and the transformer filled with fresh, clean, dry oil. The old oil can be filtered and used again in other transformers.

A check of the load of each transformer should be made two or three times every year, more particularly to see that no transformers are severely over-loaded, but also to find if any are not loaded up to capacity sufficiently for efficient operation. The most convenient and satisfactory method of making this check is to use a portable graphic ammeter with split-core transformers placed on the secondaries and left for at least twenty-four hours. The charts thus obtained serve as an excellent guide in rearranging secondary load, and transformers when necessary to secure most efficient results.

There are transformers on many of our distribution systems that were built quite a long while ago before idle or wattless current had become recognized as a serious factor of power cost. Some of these transformers are literally eating their heads off with exciting current. Some transformers may be found to-day that are taking an exciting current amounting to 50 per cent. or more of the full load current value. This wattless exciting current flows continuously and of course rides the peak of the system adding to the system's power cost. All old transformers should be regarded with suspicion and checked for exciting current. Any found excessive in this regard will yield handsome profits by being scrapped and replaced by new transformers.

To keep operating losses at a minimum and to prevent lowering the distribution system power factor all distribution transformers should be loaded as heavily as possible, taking into consideration duration of the peak load and the safe overload capacity of the transformers. Canadian transformers are designed to operate on 25 per cent. overload for two hours without excessive temperature rise.

Single large transformer units operate more efficiently than the same capacity in smaller units. Transformers should be used that are as large as possible considering the available load and load factor.

In rural districts where each transformer can feed only one service, transformers as small as three and five kv-a. are used, while in dense city locations we find banks of 200 kv-a. transformers located in vaults under the side-walks and in the basements of large buildings. But for the average city and town requirements the 25 kv-a. transformer seems the most suitable size.

For single-phase service on many systems, transformers are operated singly, each transformer serving only its own connected load. On some systems a secondary network is used served by a number of transformers

in parallel. When these transformers are placed a pole length or more apart, the resistance of the secondary copper between them usually compensates for any difference in impedance and regulation in the transformers so that they share up the network load evenly. This method takes advantage of the diversity of a larger number of services, and maintains a more uniform secondary voltage over the whole secondary network.

Another practice is the use of two transformers operated in series on a single-phase, three-wire, 110/220 volt network. Each transformer is connected to deliver 110 volts to one side of the three-wire network and the neutral joined to the series point between the two transformers as shown in Fig. 4. Sometimes a number of these series pairs are made to serve the network in parallel. With this arrangement, when a fuse or transformer fails it only affects one side of the service.

Three-phase distribution transformers are not commonly used in Canada. For serving three-phase electric energy to the user there are two methods of using single-phase transformers for giving three-phase secondary. For a permanent installation where no increase in load is expected, three transformers should be used. The three transformers are connected with the secondaries in closed delta (Fig. 10.) This renders the full capacity of all three transformers available.

It may be expedient when an increase in load requirements is anticipated, to use two transformers connected exactly as when three are used if one were removed. This is known as open delta (Fig. 11). With this arrangement the capacity of the transformers is reduced to 85 per cent. of the full load rating of the two transformers. Later, when the anticipated load increase occurs and more capacity is required, the delta can be closed with a third transformer. This will bring the capacity up to the total of the rated capacity of the three transformers.

In an appendix to this paper I have given twenty-one diagrams showing most of the possible arrangements for using single-phase distribution transformers.

When transformers are in service they require protection in two ways, from excessive load and from excessive voltage.

To protect from excessive load, fuses are used. No definite ruling can be given for fusing distribution transformers. Local practice and the character of the load will determine to a great extent the size of fusing to use. Naturally greater protection is secured by fusing close to the transformer capacity, but this will usually involve frequent refusing. In general, the standard practice is to fuse at about 150 to 200 per cent. of the full load rating. The common familiar porcelain fuse block can be used for sizes up to 25 kv-a. with primary voltages under 2500. For larger sizes or higher voltages, a fuse device of more capacity and better design must be shipped. The expulsion fuse is commonly used.

To protect transformers from excessive voltage, so-called lightning arresters are used. Not all excessive voltages are due to lightning, however, and protection should be afforded for excessive voltage of any magnitude from any cause.

Lightning arresters, to be properly efficient in protecting distribution line systems from excessive voltages, should be installed with each transformer on the system so that the whole line can be quickly and effectively drained of any excessive voltage before it can damage any transformer on other apparatus connected with the System.

The auto-valve lightning arrester is especially efficient for this purpose as the initial relief discharge voltage is only slightly higher than the normal line voltage and excessive voltages of a dangerous value do not have an opportunity to develop. All the lightning arresters on the System acting in parallel create a low resistance path to ground while the high-voltage condition exists, preventing any accumulation of excessively high potential value.

The electrical character of a transformer, or in other words its performance, determine its merits or suitability for the requirements of the System on which it is to be used. Six of these electrical characteristics are usually given in distribution transformer specifications. They are :

(1) Exciting current at rated voltage and frequency.

(2) Iron loss at rated voltage and frequency.

(3) Full load copper loss at 75° C.

(4) Regulation at 80 per cent. and 100 per cent. power factor.

(5) Efficiency at ¼, ½, ¾ and full load.

(6) Temperature rise of the copper in the windings under continuous operation at full load taken by measuring the rise in resistance of the windings.

It would be desirable to consider the methods to test transformers for the electrical characteristics, but these methods require considerable explanation and would take very much more time than we have.

There are various publications on transformers which give this information and it is quite likely that most of the members of this Association have copies.

Distribution System managers should give more attention to the testing and care of the transformers on their systems. There seems to be too much of a tendency to buy transformers on their nameplate rating only, and to fórget all about them after they are placed in service.

I trust that this paper and your discussion will help toward more standardization in transformer practice and more efficiency in transformer operation.

Appendix

The following diagrams show the various arrangements of connections that may be used to operate standard distribution transformers :

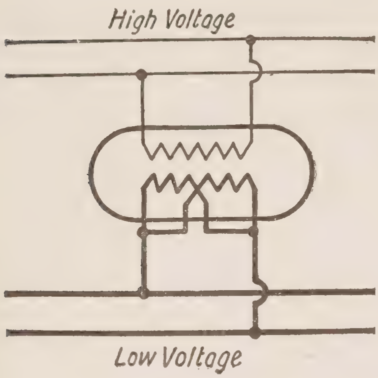


Fig 1.—Single-phase Two-wire Secondary, Parallel Connection. Used mostly for obtaining two-wire 110 volts full capacity.

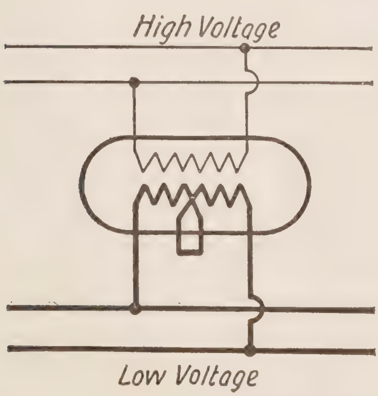


Fig. 2.—Single-phase Two-wire Secondary, Series Connection. Used to obtain 220 or 550 volts full capacity.

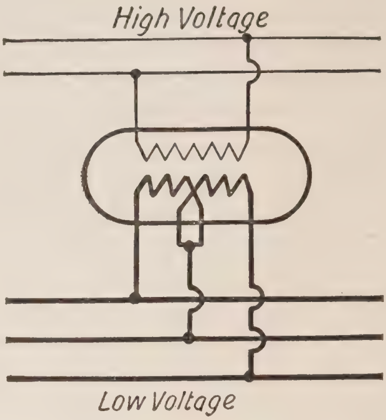


Fig. 3.—Three-phase Three-wire Secondary, Series Connection. This connection provides 110/220 volts single-phase three-wire secondary. The two sides of the circuit must be equally loaded to obtain full capacity. Neither side should be loaded to more than one-half capacity.

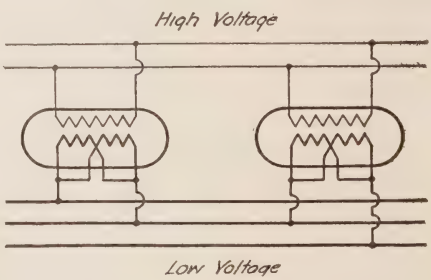


Fig. 4.—Single-phase, Three-wire, Two Transformers in Series. This is the connection to obtain single-phase three-wire with two transformers, each connected for 110 volts secondary. Each side can be loaded to the full capacity of the transformer connected to it.

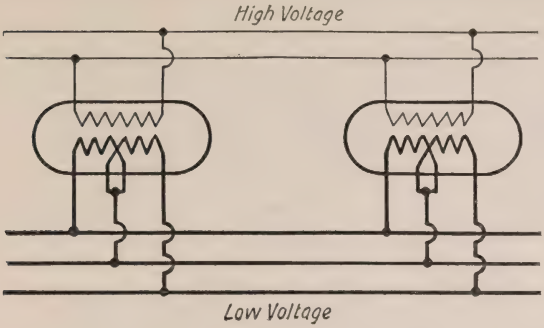


Fig. 5.—Two or More Transformers in Parallel, Single-Phase Three-Wire. This is the arrangement for paralleling two or more transformers connected as shown in Fig. 3.

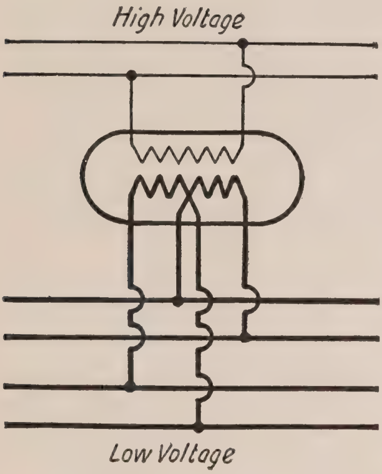


Fig. 6.—Single-phase Four-wire Secondary. When it is desired to supply two entirely separate 110 volt services from one transformer, this arrangement can be used.

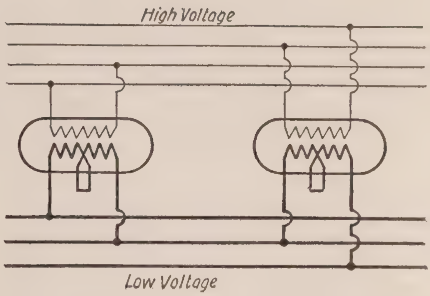


Fig. 8.—Two-phase Three-wire. With this connection, the two phases in the secondary are electrically tied together.

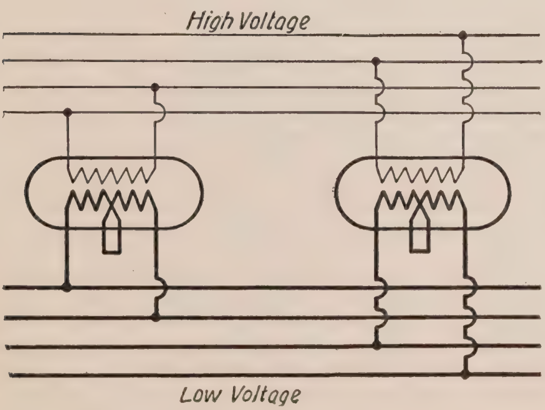


Fig. 7.—Two-Phase Four-Wire. This is the connection for transforming two-phase four-wire. With this connection the phases are electrically separated in the secondary. Either parallel or series secondary can be used according to the voltage desired.

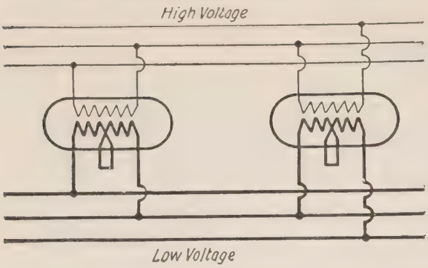


Fig. 9.—Two-phase Three-wire. With this connection the primary and secondary are both three-wire.

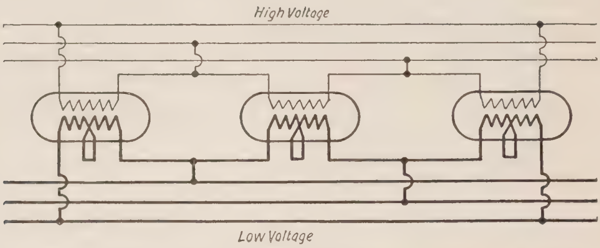


Fig. 10.—Three-Phase Three-Wire Closed Delta. This is the three-phase closed delta bank connection. These transformers should not have impedances varying more than 10 per cent. unless reactors are used.

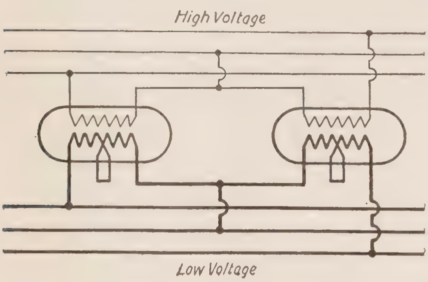


Fig. 11.—Three-phase Open Delta. This connection gives only 85 per cent. of the total capacity of the two transformers and the regulation is not quite so good as when three are used in closed delta. It is not necessary that the impedance values of the two transformers be the same unless closing the delta with a third transformer is anticipated.

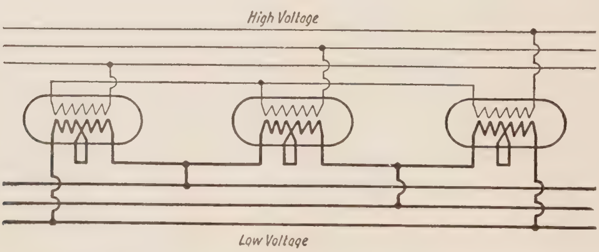


Fig. 12.—Star Three-Wire Voltage. Delta Three-Wire Low Voltage. When three transformers are operated with their high voltage windings in Star, the incoming line voltage is the square root of three, or 1.732 times the voltage of the primary windings of the transformers. It is commonly used to operate 2300 volt transformers on 4100 volt primary. With this connection it is not necessary that the impedance values of the three transformers be the same.

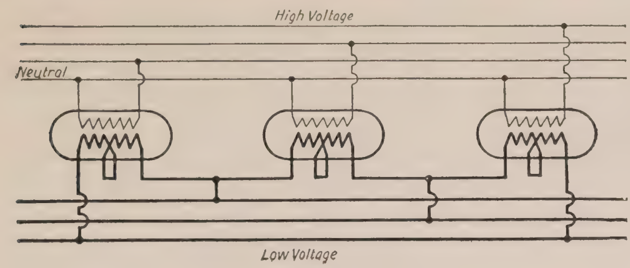


Fig. 13.—Star Four-Wire High Voltage, Delta Three-Wire Low Voltage. This is the same connection as in Fig. 12 with a fourth wire in the line provided for the Star connection.

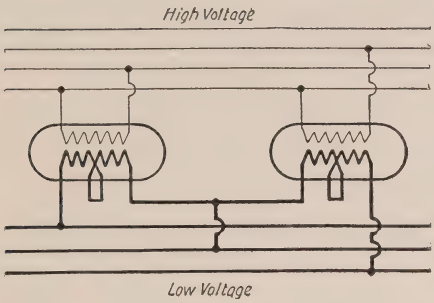


Fig. 14.—Star Three-phase High Voltage. Delta Low-voltage. One Leg Out. This connection permits the use of two transformers, as in open delta, but reduces the capacity to 85 per cent. that of the two transformers.

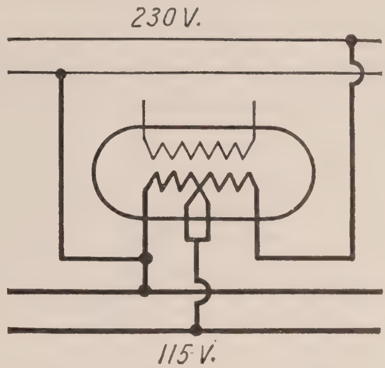


Fig. 16.—220/110 Volts Using Secondary Only. This arrangement uses the two-winding secondary as an auto-transformer to obtain half the voltage value of the incoming line. The transformer will operate at full capacity.

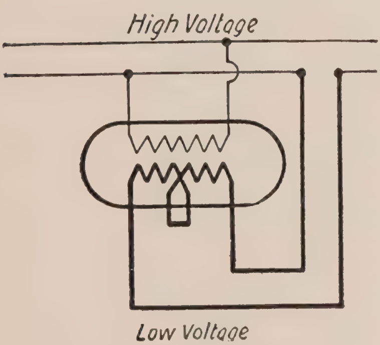


Fig. 15.—Standard Transformer as a Booster. With this connection the line voltage from which the transformer is excited can be boosted and by reversing the secondaries it can be bucked.

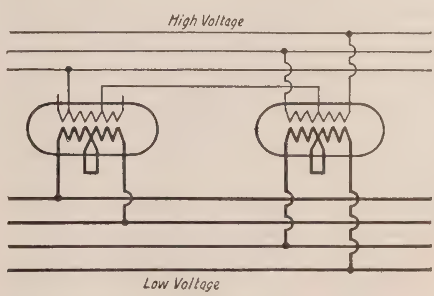


Fig. 17.—Three-phase Two-phase Transformation. Standard 10 to 1 Ratio. If a Scott transformation is desired, and a transformer having an 86.6 per cent. tap is not available, a transformer having a 10 per cent. or two 5 per cent. taps can be used to give serviceable results. The phases will be slightly unbalanced. The main unit must have a 50 per cent. tap.

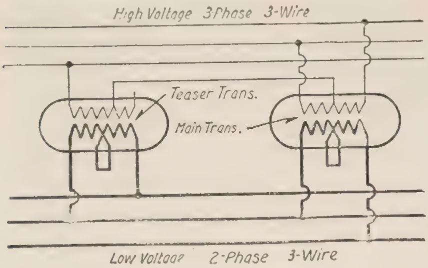


Fig. 18.—Three - phase Two - phase Three-wire Transformation, Scott Tap. This is a phase transformation from three-phase to two-phase or from two-phase to three-phase. The three-phase side must have special taps to make this transformation. One unit must have an 86.6 per cent. tap and the other unit a 50 per cent. tap. The two-phase side is three-wire. If it is to supply motors with interconnected middle points, this connection cannot be used, but it should be arranged as shown in Fig. 19, where the two phases are separated by the use of four wires.

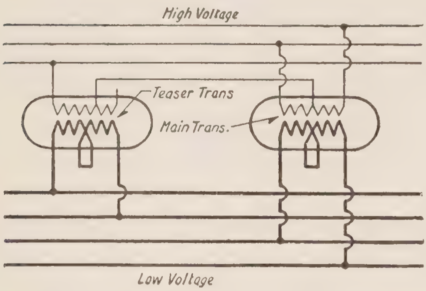


Fig. 19.—Three-phase Two-phase Four-wire Transformation, Scott Tap. This is the same as Fig. 18, except that the two-phase side is connected four-wire, the phases electrically separated.

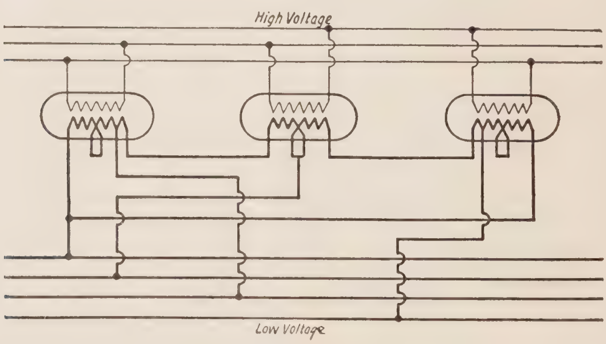


Fig. 20.—Three-Phase Two-Phase Transformation, Taylor Connection. This is a transformation from three-phase to two-phase by the use of three transformers, one of which is standard, the others having two taps in the low voltage side. One advantage of this connection is that two-phase and three-phase could be taken from the secondary at the same time. The total capacity is a little less than the total rating of the three transformers.

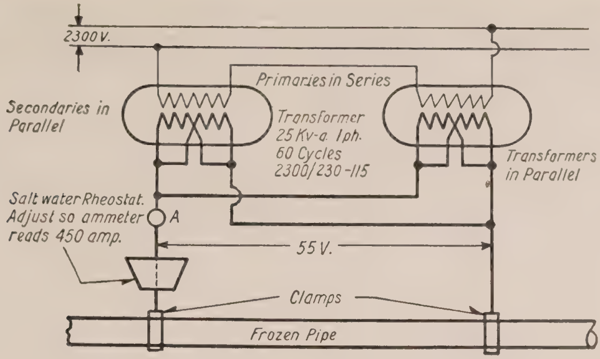


Fig. 21.—Standard Transformers for Pipe Thawing. Using two 25 kv-a standard lighting transformers connected with the primaries in series and secondaries in parallel, the cable joining to the pipes should be of ample cross section to carry 500 amperes.

A pair of these transformers with connections and rheostat should be arranged on trailer wheels and kept in readiness for winter pipe thawing use.

Discussion

Mr. H. Denef, Hanover: If water is found in the oil of a transformer, should the oil be all taken out, or just the water drained off ?

Mr. Showalter: There is some water held in suspension all through the oil, and it would not be safe to operate the transformer unless it has all the water taken out.

Mr. J. W. Peart, St. Thomas: I do not know of any piece of electric equipment that we actually make use of on our systems which is subject to as much abuse as the pole type transformer. We buy them, hang them on a pole and forget about them. We trust that they will stay there and not annoy us. The point Mr. Showalter brings out regarding testing is absolutely essential. I notice that he suggests testing on the low tension side of the transformer and, I take it that it is necessary to determine the values of the load on the secondary coil. I have found that that is more complicated when trying to get over the system and locate a fault in a short time, and have resorted to the use of current transformers cut in on the 2,200-volt side, which of course gives an indication of the load, but doesn't determine the balance. However, I believe that, if the service transformers are located under the supervision of the line superintendent and the balance determined more or less by rule of thumb, you will not be very far astray, although I agree with Mr. Showalter that it is far more ideal to test on the low tension side.

I agree with him entirely in respect to the point he mentions in regard to standardization of voltages, but I do not feel that the municipalities entirely are to blame. In recent years the Hydro-Electric Power Commission has been in a position to maintain a more or less reasonable regulation of

voltage on remote points of the system, and only some municipalities want 2,200 volt while others could use the 2,400 volt. I believe that conditions have changed so that we can get together and standardize on the 2,300 volt transformer.

That matter of losses in old transformers I regard as a very important question. I have found 2–25 kv. transformers on the system a matter of nine years and on checking the exciting current discovered it to be 32 per cent. If it were possible, it would be an excellent thing if we could go over our transformers and check the exciting current and then we might consider the matter of installing some more modern transformers.

Mr. J. E. B. Phelps: I would like to say that some schools of thought claim that in a hook-up such as on page 65, that a true three-phase isn't obtained. I would like to ask Mr. Showalter if we do get a three-phase current or not, and do motors operated on these hook-ups pull their full load without heating.

Mr. Showalter: I would suggest that Mr. Magley might answer Mr. Phelps' guestion. It is well known the phases of the open Delta transformer are out of balance. For all practical purposes, however, you get a usual balance three-phase connection from the Star connected primary transformer. It is not to be recommended for a permanent installation.

Mr. Phelps: To take a tap off the middle point of a transformer to get 110 volts for light ?

Mr. Showalter: Oh, yes.

Mr. A. J. Magley, Moloney Electric Co. of Canada, Limited: There should not be any difficulty. The transformer in that phase has sufficient capacity to carry both motor current and lighting current. It depends largely upon whether the motor current is requiring the full capacity of the transformer whether there would be any additional plant for lighting or not.

Mr. Phelps: You would get a hazard ?

Mr. Showalter: I suppose as far as grounding is concerned. It would be necessary to ground, and in that case, the maximum volts put on the motor would be slightly less than the line voltage, but not enough to cause any injury.

Mr. W. R. Catton, Brantford: I would like to know what is meant by old transformer.

Mr. Showalter: There has been a gradual change in transformer design. Before the cost of the wattless current became a factor, exciting current wasn't a disadvantage. Since the introduction of the method of charging municipalities for current on the basis of power factor, it has become desirable to have transformers that take as little exciting current as possible. Manufacturers were made aware of this, and you have now a most remarkable transformer. I might say that in the United States, where there is very little 25 cycle power, they can't believe that we have a transformer in Canada, in sizes of 25 kv-a., that consumes as small as 2 per cent. exciting current. They think it is impossible, and I think our Canadian manufacturers are to be congratulated on what they have been able to accomplish. This has come about in the matter of the last ten years.

Mr. E. V. Buchanan, London: What I have been thinking about recently is that in some of the bigger systems at least we can clear out a lot of transformers by adopting what I believe is somewhat new, the three-phase secondary network, and by using 13,000 volt transformers, stepping directly down to the consumers' voltage. I mention that point, as a suggestion to the Papers Committee, for a paper at the next meeting.

Mr. C. E. Schwenger, Toronto: I would like to ask Mr. Showalter what is the difference between the specifications of transformers, that is between the manufacturers' standard and the so-called C.E.S.A. standard.

Mr. Showalter: I should have checked that up. Is there anyone here who can answer that ?

Mr. A. B. Cooper, Ferranti Electrics Limited: I believe all Canadian transformers are in accordance with the C.E.S.A. specifications that do not in any way conflict with any manufacturers. The C.E.S.A. say that the transformer specifications do not in any way limit guarantees for loss or any other value. They attempted just to set up a standard.

Mr. A. H. Fisher, H.E.P.C. of Ont.: I would like to ask Mr. Showalter whether his statement with reference to the excessive exciting current applied to 60-cycle transformers or only 25-cycle ? The greatest I have come across in 60-cycle transformers is 20 per cent.

Mr. Showalter: If a 60-cycle transformer has 20 per cent., I don't know what you would understand of a 25-cycle. The frequency is very much higher and gives a very much lower current than the 25-cycle calls for at the same size. So the exciting current values are very low. In the 25-cycle, there has been a very definite effort made to get the exciting current down. The core must be very cleverly designed, the design very cleverly worked out, joints in the iron must be very carefully made, and the whole thing must be gone into very much more carefully. So in 60-cycles, you need not take that part of the question quite so seriously.

Mr. E. I. Sifton, Hamilton: I find that we have to size up the load we have on transformers more carefully as to whether it is an intermittent over-loading of short-period duration or whether it is a slowly increasing load, or a load which is liable to be of continuous steady overloading for hours. You will have differences in fuses in different cases. We have to fuse fairly close to the transformer capacity at times while others can stand to 200 per cent. over-loading on the fuse rating. I find that it is very advantageous on the burning out of a fuse to see that the load is checked up.

Mr. R. H. Martindale, Sudbury: Mr. Showalter raised the question of fusing secondary circuits. For the information of the members present, I might say that several years ago, we were able to obtain some 600 volt cut-outs with a rupturing capacity from 400 to 600 amperes. These cut-outs are very heavy and of substantial construction, with solid porcelain bases, having blocks in which a fuse is inserted and are housed in a wooden box. You can use the ordinary wire fuse, which can be bought from any of the supply houses and it is a very efficient cut-out on a secondary fuse. They are perfectly safe to handle,

because the whole affair has a very heavy porcelain handle.

Mr. Catton: What success are we having in getting an insulating compound that does not dissolve in oil and eventually clog up the oil ducts and spoil our transformers ?

Mr. C. A. Price, Canadian Westinghouse Co.: The manufacturers would like to be able to answer that question by saying that they have a compound that will not dissolve in oil, but we have not reached that stage yet. We have got very close to it.

Mr. Schwenger: It has been intimated that there might be a great hazard in stepping down from 13,000 volts to secondary voltage. There is no danger in working on such equipment since it is always killed before work is started.

Association of Municipal Electrical Utilities

Auditors' Report

Toronto, January 22, 1930

MR. A. W. J. STEWART,
President.
Association of Municipal Electrical Utilities of Ontario.

Dear Sir:—

We beg to advise you that in auditing the books of the Association of Municipal Electrical Utilities of Ontario for the calendar year 1929, we find the cash recorded as received by the Treasurer agrees with statements submitted by the Secretary ; disbursements are supported by vouchers, authorized and passed by both President and Secretary, and the cash balance is in agreement with the bank pass book.

We respectfully submit herewith Statement of Receipts, Disbursements and Assets.

Yours very truly,
(*Sgd.*) W. G. PIERDON,
H. P. L. HILLMAN,
Auditors.

STATEMENT OF RECEIPTS DISBURSEMENTS AND ASSETS FOR YEAR ENDING DECEMBER 31, 1929.

RECEIPTS

Cash in bank Dec. 31, 1928.		$1,267.37
Membership fees—		
Utilities......	$1,331.00	
Commercial..	380.00	
		1,711.00
Convention receipts—		
(January)............		1,526.00
O.M.E.A. contribution....		126.49
Interest on deposits......		48.76
Interest on bond.........		27.50
		$4,707.12

DISBURSEMENTS

Convention Expenses—	
Dinners and Luncheons.	$1,400.00
Entertainment.........	538.44
Printing...............	112.50
Badges................	178.55
Reporting............	201.85
Miscellaneous..........	43.25
	$2,474.59

Disbursements carried forward	$2,474.59
Remuneration, Secretary and Treasurer	250.00
Travelling expenses	182.60
Printing	88.71
Postage	24.68
Exchange on cheques	21.65
Balance in bank	1,664.89
	$4,707.12

ASSETS

Cash in bank		$1,664.89
Dominion 5½% 1934 bond par value $500 cost		513.50
Due from O.M.E.A.		165.71
Projecting machine	$243.45	
Less amount written off	121.72	121.73
		$2,465.83

Merchandising Committee Report

The Merchandising Committee held two meetings during the past year to discuss matters of interest in the operation of Hydro Shops.

At these meetings several important questions were brought up and discussed and the deliberations of the Committee are presented herewith :

First : Re Financial Statements.

It is the consensus of opinion of the members of the Merchandising Committee that the financial reports of the various Hydro Shops are valuable and the co-operation of the various municipalities operating Shops is asked in supplying such information as will permit of the preparation of comparable statements of Hydro Shop operation.

Second : Re Hydro Shop Accounting System.

The Committee felt that for the successful operation of a Hydro Shop the standard system of accounting outlined for Hydro merchandising should be installed in every municipality where merchandising activities are carried on.

Third : Re Hydro Shop Surplus.

The members of the Merchandising Committee wish to go on record as recommending that the policy outlined in the pamphlet entitled "Policy and General Rules for the Operation of a Hydro Shop" as published in 1924 be adhered to and that the system of accounting outlined therein be lived up to in all its principles, including the handling of the surplus accruing from Hydro Shop operation.

To quote the particular item in the pamphlet referred to there appears on page 13 under Section 8, 4th paragraph, the following :

"The balance shown in the advance account in the one case is a debit in the Utility's books and in the other case is a credit in the Hydro Shop books representing the amount of money invested by the Utility in the merchandising business *and automatically takes care of losses or profits which may have accumulated in the operation on the Shop.*"

Fourth : Re Sales Methods.

The method of soliciting business by the larger Hydro Shops was discussed and it was found that the most successful means of selling electrical appliances to Hydro customers was to have men out following up prospects which are picked up in the store when customers come in to pay their bills and the general scheme for

remunerating such salesmen is to give them a small salary or a drawing account and pay them a commission varying with the value of the appliances disposed of.

Fifth : Re Advertising.

It was recommended that some form of good will or confidence advertising be engaged in, such advertising to feature the Hydro Shop as belonging to the people. It was felt that by bringing more forcibly to the consumers the fact that they own the Hydro and that the Hydro Shop is their place of business more appliances will be sold through the Hydro than is now the case.

Sixth : Re Illumination Service.

The matter of utilizing the Hydro Illumination Laboratory facilities for improving factory, office and store illumination was brought up and it was decided to recommend that Hydro municipalities be advised to circularize their commercial customers notifying them of the facilities which are available for improving the illumination of their premises and soliciting any such consulting jobs as their customers may have and expressing willingness to render this service.

In this connection a representative of the Illumination Laboratory has been asked to explain the facilities offered by the Laboratory and the field which can be covered in behalf of the municipalities and their customers; all of which is respectfully submitted.

(Sgd.) J. E. B. Phelps,
Chairman.

49 Moore Avenue,
Toronto, Jan. 31–30.

Mr. S. R. A. Clement,
Sec'y, A.M.E.U.

Dear Clem :—

Many thanks for your letter of the 30th passing along the resolution of the executive regarding my absence from the Convention. Both the resolution and the flowers are very much appreciated I assure you.

I have already heard from 2 or 3 people who say the Convention was quite a success. They especially mentioned the luncheon speakers and the dinner entertainment.

I have been sitting up some lately and hope to be at work before long.

Again thanking you,

Yours truly,
(*Sgd.*) A. W. J. Stewart

Further Convention Papers and Reports will appear in March Number.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

George Wright

IN the death of Mr. George Wright in Toronto on March 17th, 1930, the City of Toronto and the municipal ownership cause in Ontario have lost a citizen of fine public spirit and tireless energy. He was prominent in the commercial, financial, civic, social, and philanthropic life of Toronto for a quarter of a century, and his passing will entail a real sense of loss in the many activities in which he took part.

An essential factor in the success of the Hydro-Electric undertaking has been the readiness with which public-spirited citizens of outstanding ability and zeal have been willing—often at personal sacrifice—to devote their time and energy to the management of the local electrical distribution systems. To such men the citizens of Ontario municipalities owe a debt of gratitude which too often is not fully recognized until the loss of their services is suffered.

George Wright

George Wright was born in Glasgow, Scotland, on November 16th, 1866. At the age of eleven he entered a training ship of the British Navy, and later served as ship's-boy and seaman in the British Merchant Marine. After ten years of life on the sea, which took him to all parts of the world, he obtained his discharge from his last ship at Vancouver, and entered the employ of the C.P.R. For the next eighteen years, Mr. Wright lived in the Canadian West, participating in the early development of that territory, and his fortunes grew

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Vol. XVII No. 3
March, 1930

and prospered with the country.

Twenty-five years ago he came to Toronto, and in partnership with E. M. Carroll purchased the Walker House. At the time of his death, as president of George Wright and Company, Wright and Carroll Investments, and actively associated with many other commercial and financial enterprises, Mr. Wright was a leader not only among hotelmen, but also in various fields of public and private endeavour. He was President of the Dominion Hotelkeepers Association in 1913, and a Vice-President of the American and Canadian Hotelkeepers Association from 1913 to 1917. He was also President of the Toronto group for a period of five years. During the war he served as Commissioner for Toronto under the Food Control Board, was a leader in activities for the welfare of soldiers and their dependents, and was a member of St. John's Ambulance Association, and of the executive council of the Canadian National Institute for the Blind.

George Wright had unfailing belief in Canada and Canada's future. His administrative ability and his enthusiasm for the cause of public ownership of utilities led in 1918 to his appointment to the Toronto Hydro-Electric Commission—a position whose duties he discharged continuously until his demise, with never flagging zeal for the public welfare. He became Chairman of the Commission after the death of Mr. P. W. Ellis last April Although Mr. Wright had been in failing health for two years, only three days before his death he left his bed to attend the meeting of the Commission. To his faithful service is due no small part of the success of the Toronto Hydro-Electric System.

At the time of the purchase of the Toronto Street Railway by the City of Toronto, George Wright was chosen as one of the three Transportation Commissioners, and served in this capacity until about two years ago. He was the last of the three original Commissioners, Mr. Fred R. Miller and Mr. P. W. Ellis having predeceased him.

In his personal attributes, Mr. Wright was richly endowed with the ability to make and retain friendships and this made him one of the most widely known and popular hotelmen on the continent. His kindliness and human qualities were particularly manifested in the special attention his hotels gave to women travelling alone, and in his personal interest in children, for whom he usually had at hand some little favor.

The many expressions of sympathy and esteem that have been shown to Mrs. Wright and to his son and daughter are but a small indication of the general feeling entertained towards them in the great loss they have sustained.

Street Lighting and Flood Lighting

By Kirk M. Reid, Director of Street Lighting and Flood Lighting, Engineering Dept., National Lamp Works, General Electric Company, Nela Park, Cleveland, Ohio.

(Address to Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Toronto, January 30, 1930.)

WHEN I am asked to talk on the general subject of street lighting and flood lighting, there is a tendency to conjure up a picture of the complexions and complexities that are involved in handling a modern street lighting system ; such things as the different types of streets and street services, the different methods of measuring street lighting, the different methods of control, the different methods of circuiting, the different types of equipment, the ever present problem of financing a street lighting system ; these are some of the complexities. And I believe it would be clarifying, therefore, if we tried to take a step away from all these details and complexities and take a general view of this problem of street lighting, and see if we cannot reduce it to its simplest terms, outlining perhaps the basic requirements first, which must be met for a good street lighting system. I think those basic requirements can be reduced to three. First, there must be sufficient illumination to facilitate the movement of vehicles and pedestrians throughout the streets of the city, without danger of accident, without fear of molestation. Second, that illumination must be provided with equipment which does not detract from the appearance of the streets either by day or by night : and Third,—the important consideration—we must provide this illumination at an expenditure which is within the funds that we have to spend.

Where elaborate ornamental equipment and extremely large lamps are employed because of the advertising value of a so-called white way lighting system, plenty of money is usually available, and the principal problem is one of attractive appearance. When I say "plenty of money" is usually available, I refer to the common experience in the United States, where the merchants are more thoroughly conversant with the sales value of lighting than the electrical industry itself is, and they do not hesitate to supplement the funds available from the Municipality for lighting their business district, with additional funds to permit them to put in the kind of system that will redound to their benefit and increase their profits. In these cases, while the level of illumination is perhaps not sufficiently great to provide really comfortable vision, it is always above the minimum requirement. For the majority of streets, however, there is only a limited amount of money available and it is this, which, in recent years, has made street lighting truly a problem. The rapid growth of Cities, the addition each year of

thousands and literally millions of motor vehicles on our already congested thoroughfares, has created an imperative need for better street lighting. At the same time, the demands on a City's treasury for other purposes have also been great, and usually they have been better advertised. As a result, the task of the street lighting engineer ordinarily resolves itself into the difficult and not particularly thankful problem of taking an insufficient amount of illumination and distributing that over the streets of a City in such a way that the deficiency is as low as he can make it.

A comparison between the per capita expenditures for street lighting during the past fifteen years or so is quite interesting. About 1910, 1911 and 1912, the per capita expenditure in the United States for street lighting was 72c. During the succeeding fifteen years that per capita expenditure has had a hard life. First of all it slumped off a bit and stayed slumped, and within the past four or five years it has commenced to take on a new lease of life, until now it is officially about $1.00. The unofficial figures for 1928, compiled in Cities of over 30,000, give $1.10, so that during the fifteen years we have gone from 72c. to about $1.00 for street lighting. During that same time the expenditure for other articles has almost trebled. The expenditure for health and sanitation has almost doubled ; for charities and protection almost double, so street lighting is badly in need of something—maybe it is advertising. In terms of the taxed dollar, that means that in 1912 about 5½c., and in 1926 about 3c. out of the taxed dollar. It is also interesting, and a little bit disquieting to me, to compare the Government figures on the per capita expenditures for street lighting with the things that we would class as luxuries. Tobacco, around $16.00, theatres and movies, around $6.00, and so on down the line. Street lighting $1.10. And it makes me just a little bit provoked to think that the people of the United States regard street lighting as not quite as important as toilet sets, (based on what they spend for them), and just a little bit more important than chewing gum. Now I don't think that is fair. What we need to do is to elevate street lighting to a lofty eminence—and then we can have some really good street lighting. Well, meanwhile we are going to stretch it as best we can, and just how great the stretching process on street lighting has had to be is perhaps better realised from the consideration that between 25 and 30 per cent. of the total acreage within cities' limits is ordinarily taken up by its streets. In all, except the main business districts, the street area far exceeds the total floor area of the adjacent buildings, and yet the annual appropriation for street lighting is only an insignificant fraction of the amount the citizens spend each year for interior illumination. To cite a single example. If we have an office space say fifty by one hundred feet, that office is not infrequently supplied with more lamps and a greater total wattage than two or three miles of the principal thoroughfare in the city in which that office is located. The ratio of the levels of illumination in

these cases is something around 600 to 1, and it is obvious that street lighting has little in common with interior lighting. If an office has a good window, the exposure levels of daylight lighting in that office will range from around ten to fifty foot candles, and artificial illumination, if it is good, will range about ten to twenty foot candles. Figures which are at least comparable with street daylight illumination, run up from 100 to as high as 10,000 candles, and at night, except in business district, the level of illumination is one-tenth to one-hundredth of a foot candle. When dealing with such meagre levels of illumination as these therefore, we have to lay aside many of the principles of interior illumination such as colour discrimination and free dimensional vision, and develop to a higher tressle such factors as haphazard vision, vision of lamp, vision of shell, vision of direct luminants which we use indoors, as these may be used in districts of perhaps one foot candle. Now, the street lighting engineer has addressed himself, almost solely, to the problem of utilization to the best advantage, of the funds he has at his disposal. Fortunately, during the past two decades, there have been such marked improvements in light production and light control that, to-day, for a given appropriation per mile, substantially better street lighting can be obtained than could be had ten to twenty years ago. On the other hand, it now appears that the refinements in lamps and accessories have progressed to a point where, unless someone makes an unexpected and revolutionary discovery in the method of producing artificial illumination, we are not going to get much more help from that direction, in view of the fact that installations to-day represent about as far as we can expect to go in the efficient utilization of light and efficient production of light.

But if the problem of the engineer of the Municipality is no longer one of engineering in the strict sense, it now becomes a problem for the engineer and for the Municipality, to evaluate street lighting in terms of what street lighting does. What are its benefits—and arrive at a conclusion if, in the long run, it would not be economy for them to spend more money on this activity. Well, that leads them to why are they interested as Municipalities' representatives, as engineers, in the problem of street lighting, and I think we can list the advantages of street lighting under two general headings. One of them is that street lighting may be regarded quite properly, as the show window of the City, and such things tend to stimulate other civic improvements; increasing and stabilizing real estate values, attract out of town purchasers, attract other industries, arouse civic pride, evidence, if you please, of the progressiveness of the municipality; of things that we know exist, but which it is very hard to evaluate in dollars and cents.

We may regard street lighting as a guardian of the safety and comfort of the people, and under that heading we have such things as the reduction of traffic accidents, the discouragement of crime, the assistance of the Fire and Police Departments in their night activities, and the elimination of traffic delays. Some of these can

be evaluated, and others cannot. As to the assistance that good street lighting renders to the Fire and Police Departments, you have no doubt all heard the oft quoted statement that a street lamp is as good as a policeman. It is hard to say just how much a good street lighting system will help in eliminating traffic delays. It certainly permits a lot of wholesale trucking at night, and the big trucks are probably the most prevalent cause of traffic delays and tie-ups. It certainly will permit quite rapid and a safer movement of traffic at five o'clock on winter evenings. I would like just to leave with you the thought of how big a factor this is, when we take the whole thing, and I am going to read a statement by Mr. A. B. Barber, of the Department of Commerce of the United States. Mr. Barber, of the National Conference on Street and Highway Safety, has completed a survey showing the vast loss sustained by the public through traffic delays. He concludes that two billion dollars a year is a conservative estimate. This figure does not, of course, include losses from accidents, which run high into the millions. For instance, Mr. Barber finds in down town Boston, delays in traffic run into twenty-four and a half millon dollars a year, in addition to the loss from accidents. The Chicago loss is approximately two hundred and twenty million a year. New York's annual tribute, three hundred and fifty million a year, or almost one million dollars a day. Mr. Barber is pretty much an authority, and I present his opinions for what you may think they are worth. I would hesitate to present any such large figures on my own opinion.

There are one or two general points that are always alive in the United States and, I suspect, they are always more or less alive here. One of these is the ever present question, do we or do we not employ refractors ? Perhaps that is one of the subjects that I should aggressively touch, and still, it seems to me that the answer is so definite from an engineering standpoint, that it transcends any general policy matter and, I may say that it is our recommendation that, on residence streets and on thoroughfares, refractors be employed. It is the equivalent of increasing illumination in about the proportion of the next lamp size, and the increase in cost is not in that proportion. There is substantial agreement in that in the United States, but when it comes to business districts there is not so much agreement. It is our opinion that, in the business districts where, say, buildings are only three stories or thereabouts, that the upward light is not a particularly valuable adjunct to your street illumination as a whole, and therefore it is more in line with economy and efficiency to re-direct a substantial part of that upward light down on the street surfaces, where it is directly of value. Now, where buildings are more than two, or three or four stories, I think the situation is reversed. Merchants are desirous not only of illuminating the pavement in front of their shops—they are rather proud of their fine, tall buildings, and there is a certain psychological advantage in being able to see the full building fronts, and our recommendation would be to leave

out the refractors. Where your buildings are lower, I think it is in line with economy to put them in.

One thing which is coming into considerable practice in the United States, and which I recommend to your careful consideration, is what is known as the sweeping change method of lamp replacement in street lighting. Under this method there are two different sub-headings. Some of the central stations segregate the City into different districts; keep a record of the total lamp failures per night, or per week in each of these districts and, when the rate of failure exceeds a certain figure, they go through that whole district and remove all the lamps, putting in new lamps. The other plan is merely to keep track of the burned hours and, when the burned hours have reached an average rate—the life of the lamps or a little bit over—they go through and remove all the lamps. Now, that has certain advantages. By so doing you undoubtedly remove from the circuit a great many lamps that are about to fail and, I think you will agree that, where a lamp costs us $3.00, when it has a few hours life left in it—ten per cent. we will say—it is worth only 30c., and it is usually far cheaper to sacrifice some thirty cents worth of life, than to make a special trip to replace that lamp when it burns out 50 or 100 hours later. By this method of the sweeping change, the cost per lamp on replacement is very, very markedly reduced, and the unexpected outages have been brought down to a fraction of one lamp per year, which means that it is possible to retrench very markedly on the cost of patrolling, which you men may or may not employ; but patrolling is, of course, what would be regarded as an unproductive expense. It doesn't directly result in the production of any more light and putting it down on the street, so if there is any system whereby that can be reduced it is a step towards the ultimate economy. Each lamp that is taken out in this sweeping change method is examined, and if it shows a blackened bulb, or a sagged or pitted filament, and that it is about at the end of its life, it is broken up. About a quarter of those that show they still have considerable useful life in them are saved and re-used for replacements of the occasional burn-outs that occur in the new batch of lamps.

Another item that is coming in for a great deal of attention in the United States is the matter of series or multiple distribution and, gentlemen, we are not going to decide that here or in any meeting of this kind. The only one that is going to decide that is your Superintendent of distribution, sitting down before his draughting board with map sheets before him, and figuring whether, in your particular city, with your particular problems, the series or multiple is the more economical system to use. In the United States the trend is distinctly toward the multiple system, and I believe in order to understand why that is so we have to go back to the very beginning of electric street lighting, and when we do that, there are three basic reasons why this series system was almost universally employed at the beginning. The first of these was that the arc lamp was practically the only illuminant,

and the arc lamp, of course, is inherently a constant current device and therefore calls for a series circuit. The second consideration was that street lighting was one of the first forms of lighting to be installed, and the street lighting systems often usually went beyond any other type of lighting, and the series circuit is the most economical method of serving a string of rather widely connected units when there is no other source of service available. The third factor was that series circuits are very easy to control. The problem of turning them on or off was quite simple, and so, as a result of those three things, street lighting started out almost one hundred per cent. series. Now, we can see what ones of those conditions still exist. The arc lamp is no longer a dominant factor in street lighting. It is becoming less and less a factor, and incandescent lamps may be operated on either series or multiple distributions, depending on whether they are designed for constant current operation, or constant voltage operation. The second thing is that street lighting systems no longer extend far beyond the multiple distribution system applied to the residences, and that condition no longer exists in favour of the series system. So we really come down, it seems to me, to one pressing problem and that is the problem of control, and whenever a control system can be shown under local conditions to permit the installation of multiple street lighting, more economically than series, then the series gives way to the multiple control. You have, of course, such things as your investments in series equipment of all kinds, and that must be given very careful consideration whenever you are thinking of changing an old system and putting in a new one. But with the new systems, I suggest you figure rather carefully whether it might not be economical for you to make additions and new systems multiple.

The Problem of Power Metering with Particular Reference to Errors in Connections

By W. H. Gerrie, Meter Inspector, H.E.P.C., of Ont.

(Read before Association of Electrical Utilities at Toronto, January 30, 1930.)

THE purpose of this paper is to record some of the difficulties experienced with 3 phase power metering equipments that are incorrectly connected. The paper is not intended as a description of the various forms of metering equipments, nor is it a detailed account of the various forms of metering connections in general use to-day. A few typical cases of 3 phase metering connections are analyzed showing the results of wrong connections and the methods in use for detecting these errors. The paper concludes with a suggestion of the possibility of reliable, initial and periodic inspection of power metering equipments.

I will discuss this subject under the following headings:

(1) General Considerations.

(2) Theoretical Equations.

(*a*) The 3 phase 3 wire power equation.

(*b*) The 3 phase 4 wire power equation.

(*c*) Development of equation for a wrongly connected meter.

(*d*) Equations of some cases of wrongly connected metering equipments met in practice.

(3) Some Causes For Errors In Connections.

(4) Inspection.

(*a*) Initial.

(*b*) Periodic.

(1) General Considerations.

The question is sometimes asked "How many ways can you connect a polyphase meter and how many of these ways are correct?" The answer to this question is rather involved because it depends on the type of metering, the number of instrument transformers in use and the number of terminals on the meter. We usually have two terminals for each of the current and potential coils, but in some cases only three potential terminals are brought out on the two element meter. In the case of 3 phase 4 wire metering equipments some companies prefer to use a meter equipped with three current coils and two potential elements making a total of ten terminals in all, while other companies prefer to use three current coils and three potential coils making twelve terminals in all. In this section of the country the two element meter has come into almost universal use as it is interchangeable on either 3 phase 3 wire or 3 phase 4 wire systems.

In order to give you some idea of the number of combinations that can be expected we will take the standard two element meter with two current terminals for each element and two potential terminals for each element, or eight terminals in all. The number of different arrangements for the voltage connection can be given by the expression $Y = \underline{|X}$, where X is the number of voltage terminals of the meter and Y the number of different arrangements of different connections. For each arrangement of the voltage terminals there are sixteen combinations that may be formed by the current connections and by the opening of the voltage leads. These arrangements may be listed as follows:

(1) Phase A and phase C connected correctly.

(2) Phase A reversed, phase C correct.

(3) Phase A correct, phase C reversed.

(4) Phase A and phase C reversed.

(5) Phase A and phase C correct, voltage lead *a* open.

(6) Phase A and phase C correct, voltage lead *b* open.

(7) Phase A and phase C correct, voltage lead *c* open.

(8) Phase A reversed, phase C correct, voltage lead *a* open.

(9) Phase A reversed, phase C correct, voltage lead *b* open.

(10) Phase A reversed, phase C correct, voltage lead *c* open.

(11) Phase A correct, phase C reversed, voltage lead *a* open.

(12) Phase A correct, phase C reversed, voltage lead *b* open.
(13) Phase A correct, phase C reversed, voltage lead *c* open.
(14) Phase A and phase C reversed, voltage lead *a* open.
(15) Phase A and phase C reversed, voltage lead *b* open.
(16) Phase A and phase C reversed, voltage lead *c* open.

There are also twenty-four additional arrangements for the voltage connections possible by interchanging the main potential supply leads as follows :

(1) Twelve arrangements by connecting the two commons to phase *a* in place of phase *b*, and one to phase *b* and one to phase *c*.
(2) Twelve arrangements from connecting the two commons to phase *c* and one to phase *a* and one to phase b.

From the above it will be seen that we have a total of 192 theoretically different possible connections for this class of meter when used with potential transformers. Add to this the combinations of potential transformers and in some connections of current transformers, to say nothing of the combinations from a phase shifting transformer commonly used with a certain make of demand meter and you will appreciate that you have a very nice problem in permutations and combinations.

The above figure of 192 can however be reduced to 144 because 48 of these theoretical cases can be considered as non-existent. It can be shown that there are 64 cases or arrangements of connections where the meter will run in the right direction at some value of power factor between unity and zero lagging. There are 40 of these 64 which occur on open circuits and 24 when all circuits are intact. If we assume that all meters and instrument transformers are tested for open circuits before they are installed, our problem in this particular type of meter is reduced to 24 cases. You will see therefore that a sufficient number of wrong connections remain possible and enough to warrant reliable inspection, particularly when used with instrument transformers.

If we were always able to connect our meter in close proximity to our instrument transformers, some of the chances of errors in connections would no doubt be eliminated. However, in practice our instrument transformers are generally located at some distance from the meter and in many cases on a pole outside the building. A run of conduit carrying the secondaries usually intervenes between the instrument transformers and the meter resulting in various possible combinations of connections which are wrong. The alarming part of this situation is that at certain power factors with wrong connections the meter will actually read correct, and if one were to follow the old form of testing, namely, applying first one potential and then the other potential to the meter, he would find himself in the position of thinking the meter was connected properly when in reality it was connected wrong. In order to emphasize this particular point I will develop from first principles the ordinary 3 phase power equation, and then using the same form of analysis

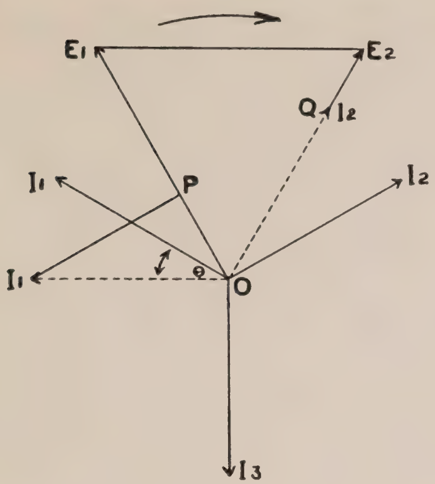


FIG. I

derive an equation for one type of wrong connection that we meet in practice.

(2)—Theoretical Power Equations

(*a*) The 3 phase 3 wire equation.

A casual inspection of the polyphase metering circuit on a 3 phase 3 wire system will indicate that at unity power factor the current in the one phase is leading its potential by an angle of 30° and the current in the remaining phase is lagging its potential by an angle of 30°. The above angular relation between currents and voltages is necessary for 3 phase power measurements as will be seen from the following mathematical deduction.

In *Fig. 1*, E_1 O E_2 represents a voltage triangle for a balanced 3 phase 3 wire system, voltages being taken phase to phase. The vectors I_1 I_2 I_3 represent the three currents in this system at unity power factor. For convenience of plotting, the voltage triangle is moved up so that the lower apex coincides with the neutral point of the three current vectors. The arrow indicates the direction of rotation of the vectors. Current I_1 represents the current in one phase of a metering equipment which is associated with voltage E_1. Current I_2 represents the meter's other current which is associated with its voltage E_2.

We will assume the current system to drop back an angle of 30° corresponding to a power factor of 86.6 per cent. lag. The power components of the respective phases can now be obtained by dropping projections from the meter currents in their new positions to their respective voltages. These appear as OP and OQ respectively in *Fig. 1*. The algebraic sum OP + OQ therefore represents the total power in the circuit, and the individual lengths OP and OQ represent the relative watts in the two elements of the polyphase meter, or in other words the quantities measured by two single phase wattmeters connected in the same circuit.

Solving for these power components we obtain—

$$OP = E_1 I_1 \cos (30 + \theta)$$
$$OQ = E_2 I_2 \cos (30 - \theta)$$
$$OP + OQ = E_1 I_1 \cos (30 + \theta) + E_2 I_2 \cos (30 - \theta)$$

Expanding this trigonometric equation and substituting EI for E_1 I_1 and E_2 I_2 we obtain thefollowing expression :—

$OP + OQ = 1.73$ E I $\cos \theta$, where θ is the phase angle of the load.

(*b*)—*3 Phase 4 Wire Equation.*

In *Fig. 2* we have the voltages E_A E_C representing the phase to neutral voltage and therefore dis-

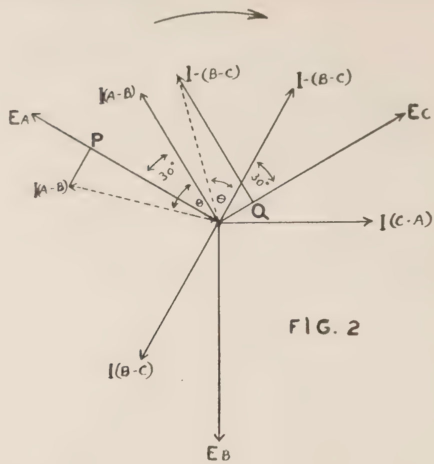


FIG. 2

placed 120° apart. The current vectors are $I_{(A-B)}$ $I_{(B-C)}$ $I_{(C-A)}$ which are the resultant currents of three current transformers delta connected on the secondaries. These currents are displaced from their respective voltages by 30°. If phase A is one of the meter phases then the current $I_{(A-B)}$ can be associated with voltage E_A and the power components for this phase would then be E_A $I_{(A-B)}$ cos $(30-\Theta)$ where Θ is the phase angle of the load. This current would represent the leading current element.

In order to have a lagging element to the meter to give an expression cos $(30+\Theta)$ it will be necessary to associate current $I_{(B-C)}$ reversed with voltage E.

From here on the derivation of the equation is similar to that of the 3 phase 3 wire equation.

You will observe one difference between the values of the vectors of the 4 wire equipment as compared with the 3 wire equipment. Voltages used in the 4 wire equipment are phase to neutral and therefore only 57.7 per cent. of the value of the voltage used in the standard 3 phase equation, namely phase to phase. This, however, is taken care of in the magnitude of the current which is 1.73 times the current used in the 3 wire equation.

(*c*)—*Development of equation of a wrongly connected meter.*

In *Fig. 3* we have a case of a 3 phase 3 wire metering equipment connected with its leading current correct but its lagging current reversed. This reversal may have occurred by wrong polarity of the current element, or the current transformer or by external connections. The vector diagram for this connection shows the current I_1 reversed associated with its voltage E_1 and therefore displaced 150° in the lead position in place of 30° on the lag. The wattmeter indication for phase E_1 will therefore be E_1 I_1 cos $(150-\Theta)$.

Indicated power in phase E_2: will be E_2 I_2 cos $(30-\Theta)$.

Indicated kw. of meter $=$ E I cos $(150-\Theta)$ $+$ cos $(30-\Theta)$.

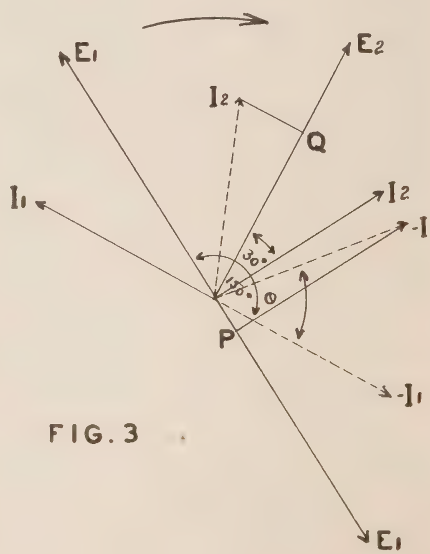


FIG. 3

Connection	Mathematical Expression	Simplified Expression
3 phase 3 wire lagging current correct leading current reversed	$EI \cos(30+\theta)+\cos(150+\theta)$	$-EI \sin\theta$
3 phase 3 wire leading current correct lagging current reversed	$EI \cos(30-\theta)+\cos(150-\theta)$	$+EI \sin\theta$
3 phase 3 wire leading current correct middle current reversed and used on lagging element.	$EI \cos(30-\theta)+\cos(30-\theta)$	$EI\ (1.73\cos\theta+\sin\theta)$
3 phase 3 wire lagging current correct middle current reversed on leading element.	$EI \cos(30+\theta)+\cos(30+\theta)$	$EI\ (1.73\cos\theta-\sin\theta)$
3 phase 3 wire leading current on lagging element, middle current on leading element.	$EI \cos(30+\theta)+\cos(90+\theta)$	$\frac{EI\ (1.73\cos\theta+\sin\theta)}{2}$
3 phase 4 wire without lagging current reversed.	$EI \cos(30-\theta)+\cos(150-\theta)$	$+EI \sin\theta$
3 phase 4 wire with Z connection on current transformer.	$\frac{EI \cos(60+\theta)}{1.73}+\cos(60-\theta)$	$\frac{EI \cos\theta}{1.73}$
3 phase 4 wire with Z connected current transformer secondaries current crossed, one current reversed, meter currents in phase with voltages.	$\frac{EI \cos(0+\theta)}{1.73}+\cos(0+\theta)$	$\frac{2\ EI \cos\theta}{1.73}$

The above trigonometric expression when expanded will be found to be = $+ E I \sin\theta$ in place of $1.73 E I \cos\theta$.

It will be apparent that we can plot a curve of indicated kw. in per cent. of true kw. =

$$\frac{E\ I \sin \Theta}{1.73\ E\ I \cos \Theta} \times 100$$

against per cent. true power factor.

This curve will indicate that at 50 per cent. power factor, the above incorrectly connected meter would actually measure true power in the circuit. At 70 per cent. power factor, it would read 60 per cent. of the true kw., while at 45 per cent. power factor it would read 115 per cent. of true kw.

This method of solving for incorrectly connected 3 phase meters is sometimes very useful in correcting power bills of meters that have been connected wrong if the mistake is found inside of a few months time. In using this correction curve on a demand or graphic meter it is necessary of course to assume that the peak as indicated by the wrong connection would have occurred at the same time as the peak indicated by the meter if connected correctly. The above suggestion for correcting a power bill is given of course with due regard to this point, and at least serves to give an educated guess rather than an approximation in adjusting the bill.

It will be apparent from the above reasoning that an equation can be obtained for different forms of wrong connections and that the correction curve thus obtained depends upon the power factor of the circuit. It will also be apparent that the correction curve will be different for different forms of connections. In order to give you some idea of equations that are obtained you will find above in tabulated form a few typical examples of meters connected incorrectly together with the equations representing their indications.

(3)—Some Causes for Errors in Connections.

Some factors that may be said to complicate the correct connection of meters may be enumerated as follows:

(1) Power factor of load.
(2) Unbalanced load or voltage.
(3) Possibility of wrong name plate data on instrument transformers and meters.
(4) Possibility of ratio errors of instrument transformers.
(5) Wrong polarity markings on instrument transformers.
(6) Wrong internal connections of meters.
(7) Inadvertent placing or occurrence of ground other than the ground placed for protection purposes.
(8) Inadvertent shunting of current circuits by auxiliary apparatus.
(9) Phase rotation of phase shifting transformers when measuring in terms of kv-a.

Referring in detail to the above factors, we have already pointed out how phase angle of the load will affect a polyphase meter incorrectly connected. I have endeavoured to point out where it is possible to obtain a correct indication of load at certain power factors on a polyphase meter incorrectly connected and yet read both high and low at other power factors with the same connection. In addition it will be seen that the power factor at which this correct reading is obtained for an incorrectly connected meter varies for different cases of wrong connections. I wish to emphasize this particular point and if you do not carry away from the

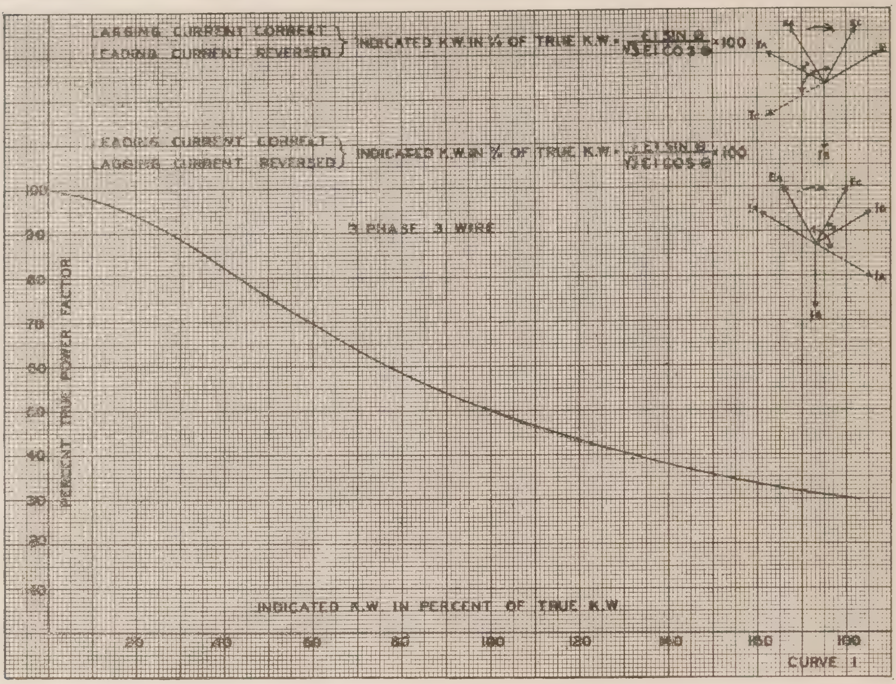
meeting any other than this idea I will feel that the paper has been justified.

The second item under this heading, namely unbalanced voltage and load conditions, is one that is generally applicable to 3 phase, 4 wire systems, or open delta transformer banks. Generally speaking unbalanced voltage alone does not introduce serious complication, but when linked up with a badly unbalanced 3 phase 4 wire system quite often produces some very weird looking vectors. The writer has run into a number of cases on 3 phase 4 wire systems where the vectors plotted resemble more the vectors obtained from a Z connection. This would indicate a current transformer secondary reversed in a group of three current transformers with their secondaries delta connected. When a condition of this kind is encountered, it is necessary to obtain readings with a 3 phase motor connected to the system either loaded or running light at a time when the system is carrying a small load, or obtain an interruption to the circuit and run very careful polarity tests on the current transformers. Incidentally I might say that the problem of obtaining satisfactory load readings on 3 phase 4 wire rural lines where the load is connected phase to neutral constitutes a real bug-bear that the meter engineer runs up against in practice.

Referring to the question of wrong name plate data and ratio errors on instrument transformers I may say, that while not a general case of trouble has at least happened a sufficient number of times that we must ever keep this point in mind. We have actually had cases of current transformers received from the manufacturer with a 50:5 name plate ratio where the actual ratio was 25:5. We have also had cases of instrument transformers removed from service where the ratio was in error by approximately 8 to 10 per cent. due possibly to partial damage from lightning or some other abnormal condition. In our Belleville Meter shop we now follow the practice of making ratio and polarity tests on all instrument transformers whether purchased new from the manufacturer or coming in from old equipments.

Referring to the sixth item in the above list I may say that there have been very few cases of meters coming from the manufacturer with wrong internal connections. There have been a few, however, and as a result we consider this one of the important tests to run on all meters. For example check readings with the standard meter may give proper vectorial arrangements of currents and voltages from the instrument transformer secondaries and yet have the wrong vectorial relation in the billing meter itself.

There is another case of wrong internal connections in meters which is not due to the manufacturer. The writer has actually run into cases where the internal connections of the meter had been changed to take care of reversed polarity of a current transformer. It has always been a puzzle to me why such a practice should be followed particularly when the polarity reversal could easily be made at the meter terminals external to the meter, if it was impossible to obtain an interruption to correct the



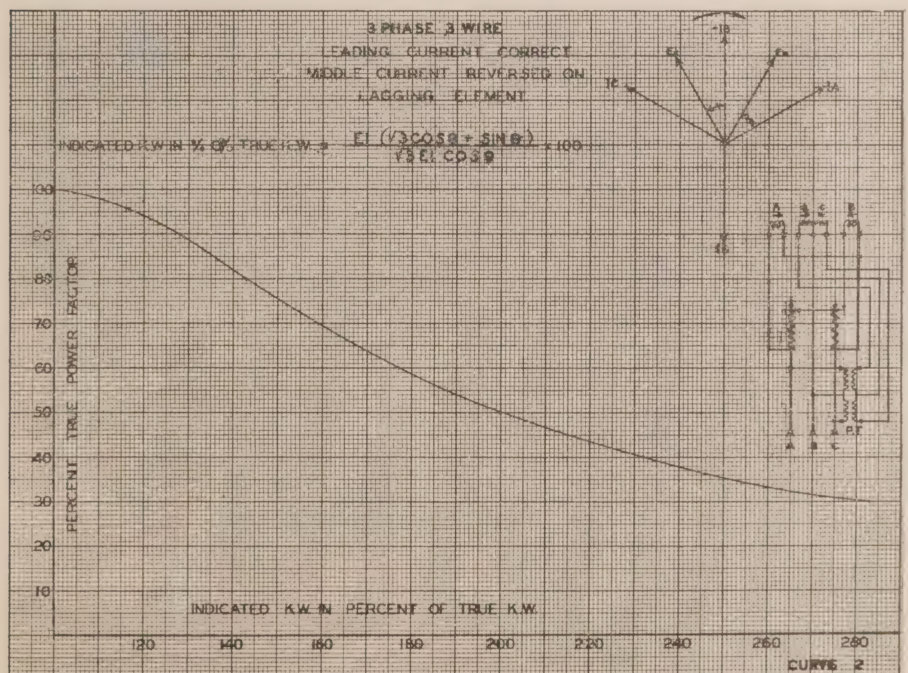
instrument transformer polarity itself. The only reason we can attribute to this practice is that the wireman might be desirous of making his meter wiring have the appearance of a proper external connection. It is a practice that we have always condemned most emphatically and our men are under strict instructions that under no circumstances is the reversal of polarity of a current transformer to be corrected by an internal reversal on a meter. Where possible we have required the load to be interrupted and the current transformer polarity corrected at the transformer.

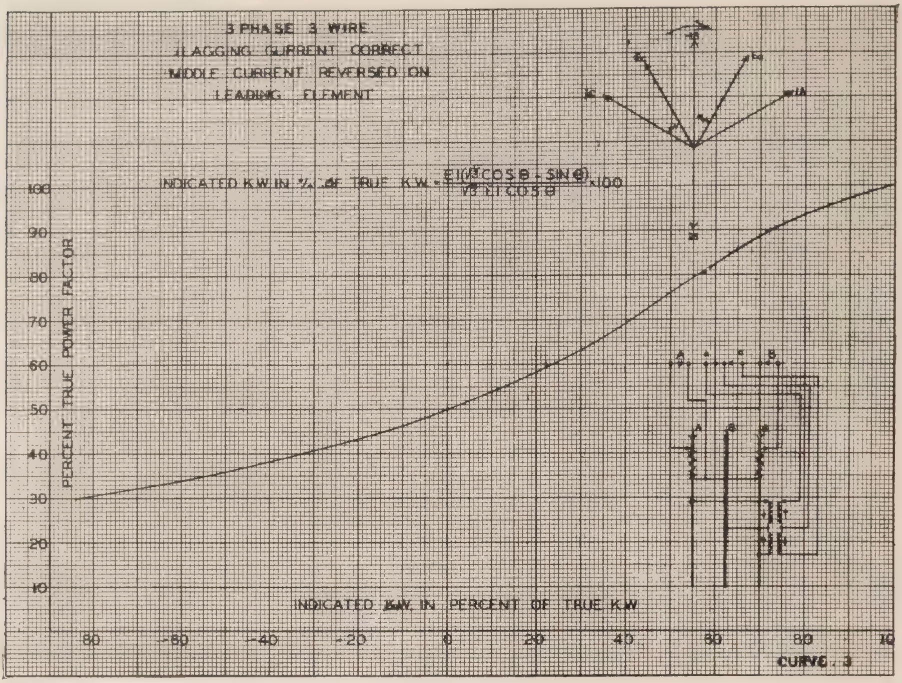
The question of inadvertent placing or occurrence of grounds on a meter circuit is one that the meter engineer must always bear in mind. The writer has had experience with a number of cases of this kind and I wish to cite one case in particular where I was called in to verify the indications of a metering equipment on a very large customer. The metering equipment consisted of the usual quota of indicating instruments including an indicating wattmeter and indicating ammeters for the 3 phases of each of three feeders, and these feeders were totalized by paralleling the current transformer secondaries through a graphic demand meter. Charts obtained from this graphic demand meter were used for billing this customer. The manager did not request any thorough check of the instrument transformer connections, but merely asked that his instruments be calibrated. The calibration proved to be fairly satisfactory and was at least within the allowable limits. When load readings were taken with the standard wattmeter, however, it was observed that one of the metered

current vectors was only 75 per cent. of the length of the other metered current. At the same time there was no unbalance observed in the ammeter readings of the individual feeders. The manager, when questioned by the writer as to whether he had observed any discrepancy in his billing, advised he had been under the impression that the meter was reading low but the customer on the other hand was complaining of excessive power bills.

Investigation revealed the fact that a ground existed on one current element of an auxiliary piece of apparatus whose current coils were connected ahead of the current coils of the totalizing meter. A shunt path therefore existed on the one element of the totalizing meter resulting in a 20 per cent. deficiency in the meter's indication at the power factor of the load when the test was taken. It is quite possible that this ground had actually existed on this equipment since its initial installation, and therefore had a thorough inspection been made of this equipment by a competent meter engineer, considerable increase in revenue would have resulted, and unpleasant explanations would have been unnecessary.

Item No. 8 comes in the same category as Item No. 7. It sometimes happens that relays are supplied from the same current transformer secondaries as billing meters, although generally speaking a separate set of current transformers is installed for relay purposes. We had a case just recently, however, where a set of circuit opening relays was connected to the supply from the current transformer secondaries before going to the billing meter. The trip coils





of the breaker were found shunting current away from the metering equipment.

(4)—Inspection.

The foregoing remarks will no doubt indicate to you the necessity and importance of reliable inspection of power metering equipments. The annual report issued by the Hydro-Electric Power Commission of Ontario shows that in the average Hydro municipality the power customers contribute between 28 and 30 per cent. of the total electrical revenue to the Utilities. In a strictly industrial centre this type of load sometimes reaches as high as 40 per cent. of the total revenue. It would appear therefore that the amount of revenue involved would warrant the expense of careful inspection. Apart from the financial end there is the good will of your customer, and I think you will all agree that in a problem that is essentially technical, very little if any satisfaction can be obtained where legal men unfamiliar with the principles of correct power metering are brought in to settle differences in power billing.

There are two classes of men usually found in practice who are responsible for the verification of meter equipment connections, namely—

(1) The engineer who knows the vector relation between the voltages and currents.

(2) The station man or local town meterman who depends on rule of thumb methods for his checking.

From the cases already outlined it will be apparent that the latter class of men would never give any real assurance of a correctly connected

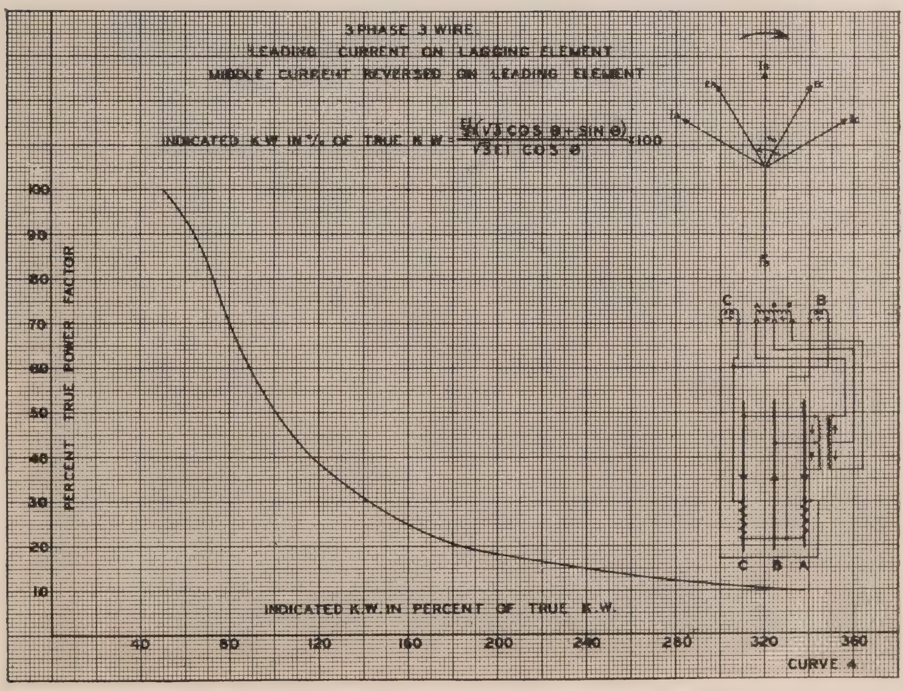
meter, particularly where some abnormal condition exists. The engineer on the other hand will go to his problem equipped with a voltmeter and wattmeter and will analyze his metering from various angles. To him the wattmeter standard is the same as a transit to a civil engineer. It is his instrument for analyzing not only what is going on in the meter circuit but what is going on in the power circuit. He will no doubt make tests similar to those made by the station man such as continuity of circuits, calibration of instruments and verification of the wiring diagram, but in addition he will undoubtedly take readings with his wattmeter and where possible with the billing instrument itself and determine the complete picture of what is taking place in the power circuit.

He will also assure himself that his current and voltage vectors are correct in magnitude, phase position and rotation. In the case of demand meters he will be unable to obtain satisfactory direct and crossed readings from the meter itself for vector plotting, but he will be all the more careful therefore in plotting the vectors obtained from his standard. In this case several sets of readings will no doubt be taken so that the average of these will give him an idea of what to expect on his demand meter and if anything unusual appears in the picture, he will make some endeavour to find out why this condition exists.

Inspection may be classified under two headings, namely,

(*a*) Initial.
(*b*) Periodic.

Initial inspection should cover the following points:



(1) Obtain a correct list of all metering equipment with name plate data.
(2) Verification of connections with complete wiring diagram.
(3) Verification of polarity of instrument transformers.
(4) Verification of instrument transformer ratio.
(5) Calibration of instruments.
(6) Obtain satisfactory load readings.

The above items have already been pretty well covered with the exception of the calibration of instruments. In addition to the elimination of ordinary calibration errors, calibration tests should eliminate errors in multipliers. This is a frequent type of error that is met in practice, and one that there is absolutely no reason to justify. Careful tests are quite often taken on watthour meters by taking disc speeds at different percentages of load together with power factor tests and yet dial train tests are omitted. A multiplier containing instrument transformer ratio should never be applied to a watthour meter unless dial train ratio has been ascertained.

Periodic inspection usually consists of calibration of the billing instruments and verification of the condition of the instrument transformers. The latter point can usually be checked by comparison of load readings against previous readings on the same equipment, although on very important customers involving large power bills frequent overall instrument transformer tests should be conducted.

Errors eliminated by frequent instrument calibration usually more than justify the inspection, particularly on instruments of the graphic and demand type. Where suitable testing facilities are supplied, it is quite possible to have non-technical labor carry on this type of inspection. The frequency of periodic inspection will depend upon the size of the customer's load. On customers taking between 50 and 100 h.p. periodic tests should be taken at least once every two years. Metering equipments measuring loads between 100 and 200 h.p. should be inspected at least once every year and if possible semi-annually. On all power customers in excess of 200 h.p. we believe that three or four inspections should be carried out during the year to do justice to the Utility and to the customer.

Frequent inspections not only eliminate calibration errors but also detect defective current transformers and changes in the customer's load conditions. A defective current transformer may make itself apparent in the meter readings, but at certain power factors it may be that the error will go unobserved for sometime if the defective current transformer is on the lagging phase.

We have frequently detected three phase motors running single phase and the customer unaware of this condition. We have also been able to detect wrong name plates on induction motors by checking up on the reactive load.

At this point I would like to make an appeal to utilities managers in the matter of location of their metering equipments and supplying testing facilities for these equipments. In the past the general practice seems to have been to locate the power meter in some part of the customer'

premises where it will be out of the way and less liable to be subject to damage. Sometimes no consideration is given to the time when a test is required to be taken on an equipment and if no testing facilities are supplied, the time required to make the inspection is considerably increased to say nothing of the hazard that the inspector is sometimes called upon to take. I am glad to state, however, that there has been a change of late as Utility managers are beginning to realize the importance of periodic inspection.

In conclusion I trust that the above remarks given at random on this all important subject will bring to your attention the possibilities of reliable inspection. It would be unreasonable to expect one to grasp the full significance of the technical side of this paper in the short time at our disposal but if by relating some of the difficulties experienced in connecting up various power equipments I have been able to create a deeper interest and a real appreciation of some of the difficulties to be experienced in connecting three phase metering equipments I will feel that my time has been well spent.

Distribution Standards

By R. E. Jones, Distribution Section, Electrical Engineering Dept., H.E.P.C. of Ont.

(Read before Association of Municipal Electrical Utilities at Toronto, January 30, 1930

THIS paper consists of a review of the more recent changes in Distribution practice, more especially as regards the construction of lines in the smaller municipalities and in the rural districts. The various items will be considered in the order in which they are erected in a line.

Poles.

In Eastern Canada we still have an abundant supply of Eastern Cedar for poles. While not possessing the clean lines of the Western pole it has a far greater life in our soils. An untreated Eastern pole will probably last something over twenty years whereas a similar Western pole may not last over one-half that time in certain soil. An example of the latter was noticed recently when some 30 ft. western poles installed in 1921 on a line were replaced due to being almost rotted through at the ground line. Proper treatment of the Western Cedar and of the various pine poles increases the life greatly. Preservative treatment of poles has not been in use long enough in our part of the country to definitely set its value but so far it is known that the extra cost of the treatment is repaid at least several times due to the extended life of the timber. However, by proper treatment is not meant the mere brushing on the butt of a thin coat of cold creosote. Means must be taken to obtain a good penetration.

The use of a dating nail in each pole is of great value for future determination of pole life. It is advisable to place these nails at a fixed point in the pole—say 10 feet from the butt so that a check can be made of the depth the pole has been set in the ground

At some locations it is found economical to use a "Pole mount" to save blasting of rock or erection of a new pole as the old one can be sawn off at the ground line and supported with a "Mount."

In selecting a pole for a certain line, consideration must be given to the ultimate load to be carried both as regards the number and size of conductors, and the resulting ice and wind loads. If a number of telephone wires are to be erected on the same pole as power wires the resulting loading must be allowed for which will in most cases require a much shorter pole spacing.

When a telephone lead is placed on an existing line of power poles, rather than rebuild the pole line to the required shorter spacing at once, it may be advisable to use the poles as they are for a time and to replace them at an earlier date than would have been necessary with the power load only.

Anchors.

For anchoring we have the choice of the log and various patent anchors. There does not appear to be an anchor superior to the log in holding power, but there frequently is a saving in time and convenience of installation in favor of the patent anchor. However, this latter type should not be used without first considering the kind of soil in which it will be installed, and also the reliability of its mechanical features.

Guys.

In most cases galvanized steel cable is satisfactory, although some times the use of a copper covered cable is advisable where there are corrosive fumes present as in the vicinity of a railroad terminal.

The serving of the strands of a cable is not recommended as the galvanizing will crack under such conditions.

A point which is not given enough consideration is the distance of the anchor away from the pole. This distance should vary according to the number of conductors and their tension, the angle of the line, and the height of the pole, as well as the strength of the guy cable.

Crossarms.

It has been found that the present class of timber received for crossarms is not sufficiently seasoned to prevent shrinkage after erection and due to pins being of a harder wood, the shrinkage of the arm results in bad checking and a shortened life for the arm. To overcome this the use of the steel pin is a great help as only a 9/16 in. hole is bored in the arm instead of 1½ in. While the strength of a ½ in. steel pin is only half that of a new 1 in. locust pin, it does not greatly deteriorate with age and the lower factor of safety of the steel pin is therefore acceptable.

For angles the clamp pin is recommended both as regards strength of the pin and also the binding together of the fibres of the crossarm. Their use will in most cases permit the erection of a single arm instead of a double arm at angles. It is now possible to obtain a good clevis for deadending conductors at a reasonable price.

Conductors.

For primary circuits both bare and weatherproof conductors are in use. There is an increasing amount of the former being erected as the covering on the latter is of value only when the conductor is dry and new and may give the inexperienced lineman a false feeling of security in handling it.

For secondary circuits the use of covered wire is standard practice in America, although bare wire is used to a large extent in Europe. Bare secondaries on crossarms are beginning to appear in parts of New York State and one company in Texas has had good satisfaction with a large amount of bare conductors on brackets spaced vertically 12 in. apart. Similar construction is now being erected in four small villages on rural lines in Central Ontario. The advantages claimed for this type of secondary is less ice and wind load, tighter wires, greater percentage of original material salvaged, and negligible depreciation.

For conductors both copper and steel reinforced aluminum are in use. The former has been in use for many

years for this purpose and has given good service. The latter is a newer material and therefore looked on with suspicion by some. The standard cable of steel reinforced aluminum has a much greater strength than copper for the same conductivity and the cost is considerably less. In the rural lines this has permitted the use of a much longer pole span with a small conductor. Where the load justifies the larger conductor copper also can be used in long spans.

For services in some places the open wire is being displaced by one of two forms of duplex and triplex cable. This gives a very clean appearance to the street and permits greater clearance from telephone wires. Where accidental contact is made with the telephone circuit the rubber insulation is of great value. One form of duplex consists of a pair of 600 volt rubber covered wires with an overall weatherproof covering. The other form is a twisted pair similar to the telephone "style B." This has a pair of rubber covered wires with double braid instead of single braid twisted together. For three wire service in this type the rubber is replaced with a third braid on the neutral conductor.

The former type may be deadend either with a loop served with marlin or with a wedge grip bracket. The twisted pair may use this bracket or be attached to the insulator with a half hitch.

Transformers and Cutouts.

A large percentage of the transformers purchased now by the Commission for rural lines is of the 4400 volt type. These transformers have taps so that they may be used on 8000/4600 volts circuits, 4000/2300 volts, 4000 volts, and 2300 volts.

The past couple of years has seen a greater development in fuse cutouts than in the previous twenty years. The two most important points are the change from dry to wet process porcelain with its greater assured insulating properties, and the changes in design which make for safer operation. They are of three distinct types. There is the plug-in type in which a fuse holder with a large porcelain cap is inserted from the top into a long circular porcelain body, open at the bottom. Then there is the box with a door which holds the fuse, made of either porcelain or a composition. The former is to be preferred as having good insulation for a long life. The third is the open type switch especially suitable for the higher voltages and frequently used for line sectionalizing at the lower potentials such as 4000 and 2300 volts. It has the advantage of good insulation, visibility, and demanding the use of a stick for operation.

There are several varieties of stick on the market for operation of cutouts. At least one make has a detachable head whereby it may be adapted readily for use with different styles of cutouts.

Clamps.

During the past few years several varieties of service clamps have appeared on the market. Usually it is possible to save a great deal of time by their use instead of soldering and a good joint is obtained. An important point is the twisting of the tap wire onto the line conductor first as in soldering and then applying the

clamp. With this method there is no danger of the clamp coming loose due to vibration.

Street Lighting.

Many towns are faced with demands for additional street lights at various outlying points on their system, and have not the necessary extra capacity on the series circuits to carry the load. This may be readily taken care of by erecting multiple lamps for the new installations and controlling them from the series circuit by a series contactor, of which there are several makes.

Miscellaneous.

Several different things are being investigated now with a view to their improvement such as grounding, guy clamps, and conductor ties.

Ground testing is now becoming part of the routine of the rural superintendent and suitable testing equipments are being purchased.

It has been found that the ordinary guy clamp as applied in the field will slip when a load of 50 per cent. or less of the full strength of the 5/16 in. cable is applied. Various makes of clamps are being tested.

Vibration Tests have been carried out for the H.E.P.C. by the Aluminum Company at Massena, using various types of ties on different insulators. For these tests a large room about 150 feet by 40 feet is used. A cable of 7-No. 4 A.C.S.R. is attached to a movable weight at one end. After passing over a sheave it is attached to the arm of a vibrating machine giving in this test 1350 cycles a minute. A short distance from this point the cable is gradually fanned out so that at about 100 feet from the vibrator the 7 conductors are on one plane and 5 in. apart. They are each attached to an insulator and finally dead-ended with a turnbuckle for final adjustment. With this installation an amplitude of 1¾ in. is obtained with 7 loops of the cable, pulled up to the elastic limit.

As these tests are still proceeding the final results cannot be given, but so far several important points have come out.

It appears that among other things the ideal tie and insulator will not have an abrupt edge at the end of the insulator groove, the groove should not have too short a contact as is the case with a side tie, the tie should be firm but not bear altogether at one point, and the armour should taper the bending movement away from the point of support.

The vibration conditions in these tests are extremely severe in that the vibration is continuous whereas in the field a line conductor will vibrate only at certain periods when the surrounding conditions are suitable. These conditions consist of the contour of the surrounding country, the temperature of the air, the time of day and prevailing winds.

Ontario Municipal Electrical Association

Executive's Report

To the Officers and members of the Ontario Municipal Electric Association.

GENTLEMEN :—

Our last Annual Meeting was held in the King Edward Hotel, Toronto, on January 23rd and 24th, 1929, and it was very gratifying to note that while the attendance was not all that could be hoped for, it was greater than the previous Annual Meeting. The following resolutions were introduced :—

1. Resolution re Beck Memorial Home—*Carried.* This resolution was forwarded to the Commission and the Government, and we believe the matter was considered favorably, but for reasons that your secretary is not familiar with, it was found impossible to go on with the project at that time.

2. Resolution re Memorial at Baden Hill. This was also carried, and copy of resolution forwarded to the Government, but no action has been taken as yet.

3. Resolution in respect to Research by the Ontario Hydro Commission. This resolution was carried unanimously and copy forwarded to the Ontario Commission, and I understand a report is being presented at this Convention.

4. Resolution re Publicity, asking the Ontario Commission to provide for a fund to be used for the purposes of Publicity and to secure the necessary legislation for same. This resolution was carried and forwarded to the Commission and legislation was granted in order to provide for same.

5. Resolution re Beauharnois Power Corporation.—*Carried.* Copy of this resolution was forwarded to the Dominion Government and to the larger municipalities in Ontario, particularly the Municipalities in Eastern Ontario which would be affected more than the Western part of the province and representations were made to the Dominion Government. Following this the Beauharnois proposition was modified to quite an extent.

The Summer Convention was held at Bigwin Inn, Muskoka, and was the largest Convention in point of numbers that has been held up to the present time, there being some 350 delegates, more than 100 of these being from our Association, and the delegates were accompanied by some 200 ladies. This was a very enjoyable and profitable outing, as the mornings were given over to the work of the Convention and the afternoons to recreation, which seemed to work out admirably, and the general opinion of those in attendance seemed to be that this was the most enjoyable outing the Associations had ever held. The addresses at both the Annual Meeting and the Summer Convention, were of the usual high order, the papers read showed very careful preparation and intimate knowledge in respect to the matters dealt with.

The Pension and Insurance Plan, which we thought was definitely settled at the last Convention had to be brought up again and was finally settled and put into operation and has been taken advantage of by some twenty-two of the larger municipalities, embracing almost two million

dollars worth of Insurance and covering something over one thousand employees.

The Town of Southampton, where we were in the middle of a fight at the last Annual Meeting, has since carried their final by-law. Officials of your Association together with Engineers from the Commission, spent considerable time around Southampton, as the Private Company were doing their utmost to prevent the final by-law being carried, but we are glad to state that the people of Southampton realized the advantage of being in with the other municipalities and carried their by-law. Although the Private Company took legal steps, their case was finally dismissed at Osgoode Hall, and the Company has since gone into liquidation and I believe their properties will eventually be taken over by the Hydro Commission, and no doubt at a much more favourable price than could have been expected last year.

The Chicago Drainage Canal has been the subject of further discussion during the past year, and the decisions given by the Courts have materially strengthened the case against Chicago, and will ultimately stop the unlawful abstraction of water from the Great Lakes.

The development of Power along the St. Lawrence has long been a source of anxiety to the Municipalities of Ontario, and we may say at the present time this looks to be in a fair way for settlement, as the long-looked for conference between the Prime Minister of Canada and the Prime Ministers of Ontario and Quebec, has finally taken place, and we believe an amicable arrangement will be entered into, that will guarantee us our rights along this water-way, which will mean a great deal in the development of Ontario particularly in the Easterly part of the Province.

It must be gratifying to all those interested in Hydro development to know that the Ontario System is advancing as rapidly as last year, and is giving particular attention at the present time to the extending of Power lines throughout the rural parts of Ontario. The growth for the last two years in the rural section has been at the rate of three miles of lines for each working day in the year. Last year we were congratulating ourselves on the turning on of power from Quebec at the Station at Leaside and it is worthy of note that while this was a very large block of Power to be delivered at certain stated intervals, the demand was so great it was necessary for the Commission to ask for earlier delivery.

In September last, a letter was sent by our Association to the Commissions in the larger municipalities in Ontario asking for an estimate as to the amount of power needed during the next five years, and following this your Executive was called into conference with the Ontario Hydro Commission in connection with the proposed entering into a contract with the Beauharnois Power Corporation, and after hearing the Commissioners explain the matter and after Mr. Gaby had explained the growth of power over the last ten years, and giving estimates as to the probable growth for the next ten years, your committee approved of the contract, which has since been completed at a very favorable rate, which should

provide for the needs of the Municipalities until such time as the St. Lawrence Power is developed.

On August 15th last, Memorial Services were again held in the Cemetery at Hamilton for the late Sir Adam Beck, which had a larger attendance than any other year. Representatives from the Government, the Ontario Hydro Commission and many municipalities and various organizations being present. The Press gave full particulars of this, so it is not necessary to deal with the matter here, except as a reminder that we have not forgotten our Chieftain.

During the past year the Province of Ontario and the cause of Public Ownership has suffered a great loss in the death of two men, whose work was outstanding in the Province of Ontario. The late P. W. Ellis of Toronto who was Chairman of the Toronto Hydro and Transportation Systems and Chairman of the Queen Victoria Niagara Falls Park Commission and who was one of the earliest and foremost advocates of Public Ownership development and distribution in the Province of Ontario. Also Mr. Philip Pocock of London, a past President of this Association, and Chairman of the Public Utilities Commission in London, and the London-Port Stanley Railway System who was a very close friend of the late Sir Adam Beck, and who had given generously of his time and ability in the cause of Public Ownership. Our Association was represented at these funerals and wreaths expressing our regret were forwarded.

During the past year there have been many meetings held at different points of Ontario in respect to Hydro, your President and Secretary having addressed over 100 meetings in this respect. The work is going on, the System is becoming greater all the time, the benefits of publicly owned power are being extended more widely all the time, but people have become so accustomed to the uses of electricity at the present time that sometimes they forget the work and sacrifices that were necessary to bring this about, and it is well that meetings be held in the various districts by members of our Executive and any others who are familiar with the History of the Hydro System, as it is only by these meetings and also the aid of the Press which has been loyal and faithful to the cause at all times, that we can hope to continue to progress as we have been doing, and to combat the forces which are opposed to us, which are active at all times and in many ways that are not always apparent on the surface.

This is a brief summary of some of the activities of your Executive, space not permitting a fuller explanation, but we trust that the work that has been done may show the people of Ontario and those in other Places that when our Chief was no longer able to carry the Torch he had held for so many years, it did not fall into unworthy hands.

The following Resolutions were introduced :—

RE RURAL POWER

Moved by : Fred Newman, Picton.
Seconded by : Willoughby Ellis, Hamilton.

THAT the Association of Municipal Hydro Representatives respectfully

request the Ontario Hydro Commission to seriously consider the advisability of reducing the term of Rural Power contracts from twenty years to a term of five years. That it is our opinion that the present long term is a decided handicap in securing farm power and light contracts, as those who are opposed to Hydro have circulated the statement throughout the farming communities that this twenty year contract is a first mortgage on the property of each farmer during that term, and that it is a lien on the property even after the death of the present owner. And in our opinion, from several years experience, the short term would overcome this objection and we feel that the records will prove that any person once taking a power contract and enjoying the advantages of Hydro power to the rural consumer, could not be induced to relinquish same under any conditions that we know of.

Therefore we respectfully request that the Hydro-Electric Power Commission of Ontario give this matter their serious consideration, so that the change suggested may be brought into effect, if at all feasible.

Re St. Lawrence Power Development

Moved by : Fred Newman, Picton,
Seconded by : John C. Miller, Orillia,

That this Association desires to renew and reaffirm our opinion expressed on many previous occasions by resolutions, memorial and deputation the necessity of the development of the St. Lawrence River, adjoining the Province of Ontario for the benefit of the people of this Province. While it is true that contracts have been entered into for the development of various supplies of power in the Province of Ontario and for the purchase of large supplies of power from certain companies in the Province of Quebec, we realize that with all these contracts we have only enough power to last until the year 1935, or at the utmost, 1936. Therefore Be It Resolved that this meeting of Municipal Commissions do hereby pledge ourselves to use our utmost energy to secure the earliest possible development of the St. Lawrence River by the Ontario Hydro Commission on behalf of the Municipalities of Ontario, and we ask that our Executive Committee take such steps as in their opinion may bring this about at the earliest possible moment.

Officers for 1930

President, C. A. Maguire, Toronto; Vice-Presidents, Willoughby Ellis, Hamilton, T. W. McFarland, London Fred Newman, Picton, August R. Lang, Kitchener; Executive,—Fred Harp, Brantford, F. Biette, Chatham, J. C. Miller, Orillia, Col. W. J. Green, St. Thomas, Geo. H. Challies, Morrisburg, W. B. Reynolds, Brockville, J. E. Banwell, Windsor, Fred J. Lowe, St. Catharines, Gordon Matthews, Peterboro, Joseph Gibbons, Toronto ; Secretary-Treasurer—T. J. Hannigan, Guelph.

Report of the Pension and Insurance Committee

The Report which I am to present to you today on behalf of the Pension and Insurance Committee is one which gives us considerable satisfaction. Delegates to these Conventions have become accustomed to hearing a report from The Pension Committee. There is a difference between such previous reports and the one we are about to give you. The difference lies in the fact that previously we have had to attempt to satisfy the delegates with a report compounded of some progress and much optimism. The goal has been in the future and we have explained that we were working towards it and hoped to reach it. To-day, I am able to report the goal achieved and the Plan in operation.

The present position is that the following twenty-two Municipal Hydro-Electric Utilities have adopted the Plan :

London, Windsor, Hamilton, St. Thomas, Woodstock, Kitchener, Brantford, St. Catharines, Chatham, Stratford, Walkerville, Ottawa, Lindsay, Galt, Owen Sound, Niagara Falls, Orillia, Peterboro, Leamington, Sarnia, Essex, Belleville.

The Total Number of Employees in these Municipal Utilities under the Plan—1,003.

The Total Amount of Life Insurance is—$1,914,370.

Total Annual Deposits on the 5% basis—$78,800.

The Total Annual Deposits from Employees—$40,600.

Up to date there have been four death claims, one each in Hamilton, St. Catharines, Ottawa and Niagara Falls for a total of $6,300 or an average claim of $1,575. Three of these claims were for male employees and one female. Out of the four deaths, three could be ascribed to natural causes and one to an accident while at work.

The value of the Life Insurance Benefit in the Plan to Hydro Employees is made evident by the circumstances surrounding these claims. In one case it was the only insurance carried by the deceased.

The machinery established for the operation of the Pension Plan has been found to work smoothly and efficiently. It has not been found to impose very much additional work on the office staff of the Utilities and the necessary records have proved to be simple and easy to keep accurately. The simplicity of the procedure for dealing with Death Claims and the speed with which cheques have been issued in settlement is most gratifying.

Reports from the various Municipalities where the Plan has been adopted indicate that there is a very large measure of appreciation of the benefits by the Employee and this will undoubtedly result in a cementing of the good relationships already existing in Hydro ranks and an increase in loyalty to the service of this public Utility. Those of us who are charged with the administration of the Municipal Utilities are already finding in this Plan a useful instrument for the maintaining of the good relationships which are essential to efficiency and feel that it will be increasingly effective as years go by.

If you will visualize a map of the

Province of Ontario and think of the list of Municipalities I have read to you, where the Plan is in operation, you will see that we have already covered most of the larger centres. We are looking forward confidently to the day when every Hydro Utility, even if it has but one employee, will, nevertheless, take advantage of the opportunity of adopting this scheme.

Delegates who have not yet received detailed information and a calculation of the cost for their Commission are particularly asked while at this Convention to visit the Pension Committee Booth. There they will be able to get whatever information they require and arrange for a meeting to put the plan into effect for their Employees.

For the benefit of present employees and to lay foundations which will be helpful for future development the Committee appeal to all Municipal Hydro Utilities throughout the Province to adopt this Plan so that we may have uniformity of treatment for all Hydro Employees. The effect on the life of our Province is hard to estimate but as things stand at present it gives us satisfaction to think that in over 1,000 homes which are supported through the Hydro pay envelope there has gone this message of security and confidence in the future.

If the bread-winner is called by death the acuteness of the economic crisis created for his family is softened by the generous death benefits and wives and children are relieved from the dread of being the possible recipients of charitable or compassionate grants. As to the future these men are assured that at the end of the road, after years of faithful service to the Hydro cause, Hydro does not forget them, but has provided an avenue through which they may enjoy the evening of life, in security and peace of mind.

Sgd. V. S. McINTYRE,
Chairman,
Pension and Insurance Committee.

Association of Municipal Electrical Utilities

Report of Committee on Accident Prevention and Health Promotion

For the most part in Ontario, the distribution system in cities, towns and villages, is carried out by having a primary system at either 2200 volts delta or 4,000 volts star connected. The distribution transformers are attached to this primary system and feed a secondary system of 110/220 volts feeding into the residences and other consumers. It has been the object of those in charge of the system to maintain it in such a way that the consumers will have service at all times; to do this it has been necessary for linemen to work on live primary lines with the added hazard of this type of work. There has been a growing feeling that this hazard was not warranted by the service necessary and that in a number of cases the primary could be killed to allow the work to be done.

The following discussion is to bring out definitely the methods to carry out the work on either dead or live primaries. For the purpose of this discussion, no reference is made to 8000 volt primaries. These are always worked dead.

If a primary system is arranged so that a ring bus or alternative supply is provided, it will be possible to kill sections of the primary bus without affecting the service to be rendered to the consumers. Where this requirement warrants absolutely continuous service, these modes of design are to be recommended. By placing in the primary system, a number of sectionalizing switches, it will be possible to minimize the effect of any shut-down by simply killing a small section of the primary system. To carry out this ideal of working all primaries dead, it will be necessary that a complete organization be set up.

1. That all work possible, be done before the primary is killed.

2. That consumers be advised as to when the service will be cut; this being organized so that it will effect other processes as little as possible, and

3. That the time of the shut-down be made as short as possible; this being accomplished by complete organization prior to the shut-down.

There is no doubt that dead work on primaries is more safe, more efficient and more economical. To take but one instance : The making of a splice on two dead wires can be carried out very much more efficiently than if the wires were alive. Acting against this ideal of dead primary work, the number of various utility devices in homes, commercial consumers, factories, etc., is making it almost impossible to select a time of the day or night when the cutting of the service will not affect someone.

The qualifications of linemen have a great deal to do with the safe carrying out of any type of line work and there follows a definite classification which will be used throughout this discussion :

Class C. Lineman.

A learner is taught to climb poles. Prior to being a Class "C" lineman, he must have served sometime in a line gang to have learned the terms used. Works on dead work such as framing, guy wire, splices, etc., etc.

Class B Lineman.

Has been at least one year on Class C work. Is allowed to work on 110/220 volt wires, after showing himself capable of progressing beyond Class C.

NOTE : As he must pass a medical examination to be a Class AA lineman, it is only fair that on entering as a Class B lineman, he be given the opportunity of a medical examination before he proceeds.

Class A Lineman.

Has been at least one year on Class B work and has shown himself capable of progressing beyond this work; is allowed to work on all voltages, but does very little work on primary lines and then only under the supervision of a foreman.

Class AA Lineman.

At least five years as Class A lineman and shows capabilities of progressing beyond this class. Is capable of passing physical examination as being fit physically. Is al-

lowed to work on all classes of work.

The following equipment is referred to in the discussion :

1. Rubber Gloves.

These shall be of an approved type, capable of passing H.E.P.C. specifications for acceptance and are returned at regular intervals to the laboratory for service test.

1a. Leather Covers.

These are to be worn over the rubber gloves to protect from mechanical abrasions; to be free from holes, cuts and tears.

2. Linemen's Belts.

To be H.E.P.C. standard or equivalent.

Note : It is becoming the practice for public utilities to own and supply the belts used by the men. This practice is definitely recommended.

2a. Linemen's Spurs.

These to be of satisfactory design; the gaff of spur to be at least 1¼ in. long measured on the inside.

3. Protective Equipment.

By this is meant, line hose, insulator caps or equivalent.

4. Rubber Blankets, Etc.

To meet H.E.P.C. specifications or equivalent.

5. Rope.

The rope to be used on line work should be long fibre manilla, carefully selected and of adequate size for the work in hand. During its use, should it behome wet or frozen, it should be carefully dried and thawed. Fibre rope with wire strands shall be prohibited.

6. Switch Sticks.

Switch sticks shall be at least 5 ft. 6 in. long of wood, treated to meet the specifications of the H.E.P.C. laboratory for switch sticks or equivalent fitted at one end with suitable heads for carrying out its operation and 2 ft. from other end there shall be a recessed groove 2 in. long and painted red.

To carry out work on live primary lines of standard construction, the following is recommended :

1. That this be carried out by two Class A linemen, under the immediate supervision of a foreman (Class AA lineman), or by two Class AA linemen. They shall be supplied with a full equipment of line hose, insulator caps or equivalent, rubber blankets, tested rubber gloves with covers, linemen's belts, spurs, etc. This work shall only be allowed to be done in good weather and shall not be allowed to be done in rain, sleet or dense fog.

Note : At times in carrying out emergency work, there may be fed from the primary important loads such as hospitals, telephone exchanges waterworks, etc. It is recommended that the primary be killed temporarily; that the emergency work be carried out by stringing temporarily a primary if necessary and that the primary be again made alive. This, taking it for granted that the emergency occurred during rain, sleet or dense fog.

There shall be no work done on live primaries on sub-standard construction.

In regard to dealing with the transformer situation, the following points are to be observed :

1. In placing a transformer in a new location :

(*a*) With live primaries on the poles.

The personnel shall consist of two

Class A linemen, under the immediate supervision of a foreman (Class AA linemen) or two Class AA linemen. They shall be equipped with belts, spurs, protective equipment and necessary rope tackle. There shall also be supplied a rope sling (not wire sling) to hold tackle to the top of pole. In placing this tackle to the top of pole, the lineman shall use rubber gloves and covers and should it be necessary for him to climb through live primary lines, these shall be protected by protective equipment. Where the hoisting sling is placed below the lowest primary line arm it shall not be necessary to instal protective equipment. There should be a minimum clearance above the transformer when in place of at least 4 ft., from the primary arm. If the primary line wire is on the transformer arm, there should be a minimum of 12 in. between the line wire and the transformer case. There should be no splice in the wire between the transformer and the cut-out. In installing the transformer, the second to last operation is to connect the tap from the cut-out to the primary line; the last operation being to put the fuse in the cut-out.

(*b*) On installing transformer where the primaries are dead.

The same recommendations apply as with live primaries with the exception that the lineman may be a Class B lineman and the foreman a Class A lineman and the necessity for protecting against primary need not be carried out.

2. In replacing a transformer with another transformer, the same requirements as for new locations, should be carried out with even added precautions.

3. In re-fusing transformers, it is recommended that switch sticks with suitable heads be used, rubber gloves or a Class AA lineman be used on this work. If the cut-out is destroyed, the primary shall be killed or the cut-out or jumper put on by a Class AA lineman.

In stringing wires under high tension wires, the following points are to be observed :

1. With the high tension line alive.

The personnel shall consist of at least two Class A linemen under the immediate supervision of a foreman (Class AA lineman) or two Class AA linemen.

NOTE : There shall also be supplied a safety supervisor (Class AA lineman) whose duty it will be to watch the operations being carried out and to see that the rules laid down for this type of work are fully carried out and that the men are not doing anything of a hazardous nature to themselves, fellow-employees or the public. This duty in certain cases may also be carried out by the line foreman

They shall be equipped with the usual equipment and in addition, short pieces of wire and additional hand lines. At each cross-arm there shall be installed a tie-down wire; this being a small piece of wire tied around the cross-arm through which the wire or rope being drawn will run. In long spans, or where there is a likelihood of the wire whipping into the high tension, a hold-down rope shall be used; this being a hand line thrown over the wire and either held or pegged down. The man at the reel shall be supplied with and shall

wear rubber gloves. Not more than six (6) stretches shall be pulled at one time.

2. With the high tension line dead.

This work may be carried out by Class B linemen, under the supervision of a foreman (Class A lineman) with the usual equipment and in the usual method.

3. Service work for 110/220 volts.

1. With live primaries on the pole, the personnel shall consist of at least two Class B linemen, under the immediate supervision of a foreman (Class AA lineman). They shall be supplied with the usual equipment and to carry out the work in the usual manner but are not allowed to go near the primary line. The tap on the pole shall be made last.

2. With either a dead primary or with no primary on pole. The personnel shall consist of at least two Class B linemen, under the supervision of a foreman (Class A lineman). They shall carry out the work in the usual manner and with the usual equipment.

4. Clearing trouble.

1. Should a circuit open up, giving an indication that there has been trouble, it shall be tried at least three times unless the interruption is of a character to show that there is a serious trouble.

2. To clear trouble with the primaries alive, there shall be at least two Class A linemen under the immediate supervision of a foreman (Class AA lineman) or two Class AA linemen. They shall be equipped with the usual equipment and should carry out their work in such a manner and as rapidly as possible remove all danger of injury to the public.

3. If the primaries are dead, the personnel may consist of two Class B linemen under the immediate supervision of a foreman (Class AA lineman) and they should carry out their duties in the usual manner.

(Sgd.) A. L. Farquharson.

Chairman.

Minutes of Convention

The Twenty-Sixth Semi-Annual Convention of the Association of Municipal Electrical Utilities was held at the Royal York Hotel, Toronto, on January 29th and 30th, 1930.

On Wednesday, January 29th, the Association along with the Ontario Municipal Electrical Association and the Electric Club of Toronto met for the first Convention luncheon. Owing to the absence through illness of the President, Mr. A. W. J. Stewart, the Vice-President, Mr. R. L. Dobbin, acted as Toastmaster.

Mr. T. C. James, President of the Electric Club, gave a short address expressing the appreciation of that organization on account of it being invited to be present.

Controller James Simpson gave a short address of welcome on behalf of the Mayor of Toronto.

The guest speaker, Lieutenant-Colonel George A. Drew, was introduced by Mr. T. J. Hannigan, Secretary of the O.M.E.A. Lieutenant-Colonel Drew then gave an address of much interest in reference to misleading propaganda from the United States concerning the late war, and the desirability of the systematic circulation in this country

of correct information on this and other subjects.

The first Convention session was opened at 3.00 p.m. with the Vice-President, Mr. R. L. Dobbin, as Chairman. Ballots for the election of officers for the year 1930 which had been distributed prior to the opening of this session were collected by the scrutineers. The Secretary then read a report from the Auditors in reference to the finances of the Association for the year 1929. This report showed the Association to have started the year 1929 with cash in the bank of $1,267.37, and to have completed the year with a bank balance of $1,664.98. The total assets amounted to $2,465.83.

It was moved by Mr. H. F. Shearer, and seconded by Mr. E. Rumble, That the report of the Auditors be adopted.—*Carried.*

The Secretary then presented the names of Canadian Line Materials, Limited and Line and Cable Accessories, Limited, for commercial membership, and the following for associates :—

Messrs, H. B. Tett; C. E. Crease; N. E. Macpherson; E. R. Martyn; Adam Smith; W. C. Dymond, and A. C. Code.

It was moved by Mr. O. H. Scott, and seconded by Mr. J. W. Peart, that the names read by the Secretary for commercial and associate membership be accepted.—*Carried.*

Mr. J. E. B. Phelps, Chairman of Merchandising Committee, presented a report from that Committee and moved its adoption. On being seconded by Mr. O. H. Scott the resolution was carried.

Mr. A. L. Farquharson, Chairman, Committee on Accident Prevention and Health Promotion, presented a report from that Committee and moved its reception.

In discussing this report it was suggested that it be taken home by the members, and they be asked to prepare a discussion on it to be considered at the next Convention. The Mover and Seconder of the report revised their resolution to conform with the foregoing suggestion which was carried.

Mr. J. H. Brace, General Manager Western Division, Bell Telephone Company of Canada, Toronto, gave an address entitled "Handling of Men". Mr. Wills Maclachlan made a short comment following Mr. Brace's address and moved a hearty vote of thanks to Mr. Brace, and welcomed him back to his home town and home district. On being seconded by Mr. R. H. Starr this vote was carried.

The scrutineers then presented their report showing the result of the election of officers for the year 1930, being as follows :—

President—Mr. R. L. Dobbin

Vice-President—Mr. J. W. Peart

Secretary—Mr. S. R. A. Clement

Treasurer—Mr. R. M. Bond.

Directors:—(From membership at large)—

Messrs. E. V. Buchanan, J. E. B. Phelps, O. H. Scott.

District Directors

Niagara District—J. E. Teckoe.

Central District—C. T. Barnes.

Georgian Bay District—J. R. McLinden.

Eastern District—R. J. Smith.

Northern District—T. W. Brackinreid.

Mr. Jos. Showalter, Canadian Westinghouse Co., Ltd., Toronto, read a paper entitled "Distribution Transformers and Connections."

Discussions following Mr. Showalter's paper was by Messrs. H. Denef; J. W. Peart; J. E. B. Phelps; A. J. Magley; W. R. Catton; E. V. Buchanan; C. E. Schwenger; A. B. Cooper; A. H. Fisher; E. I. Sifton; R. H. Martindale; C. A. Price.

At 6.30 p.m. the Association met with the O.M.E.A. for the Convention dinner when Mr. C. A. Maguire, President of the O.M.E.A. was Toastmaster. Mr. S. W. Brown, Erection Engineer, Canadian Westinghouse Company, Hamilton, on behalf of the President of the Canadian Electrical Association presented resuscitation medals and certificates to Messrs. Samuel Staines, Operator, Hydro-Electric Power Commission of Ontario and Albert Barneston, Maintenance Dept., Toronto Hydro- Electric System. There were also short addresses by Controller Claude Pearce representing the Mayor of Toronto, Mr. T. L. Church, M.P., and Mr. F. A. Gaby, Chief Engineer, Hydro-Electric Power Commission of Ontario, after which entertainment by specialists under the management of Will White was provided.

The second Convention session opened at 10.00 a.m. on Thursday, January 30th. The first paper was one by Mr. W. P. Dobson, Chief Testing Engineer, H.E.P.C. of Ont., on "Testing and Research in the Hydro-Electric Power Commission of Ontario, and its relation to the municipalities." Following the paper Mr. Dobson showed a number of films illustrating work carried on in the Commission's Laboratories.

Following Mr. Dobson's paper, Mr. E. V. Buchanan gave a short address of comment on the paper and its object, and suggested that a committee be formed to assist Mr. Dobson and his staff in the extension of research activities for the Association.

It was moved by Mr. E. V. Buchanan, and seconded by Mr. O. H. Scott, THAT a committee be appointed by the Executive Committee of this Association which will assist Mr. Dobson and his Department in the extension of the work of his department.—*Carried.*

Mr. W. H. Gerrie, Meter Inspector, H.E.P.C. of Ont., read a paper entitled "The Problem of Power Metering, with Particular Reference to Errors in Connections".

Due to the absence of Mr. V. S. McIntyre the Chairman of the Committee on Pensions and Insurance, Mr. N. W. Street, read a report from that Committee.

It was moved by Mr. J. E. B. Phelps, and seconded by Mr. R. J. Smith, that the report of the Pension and Insurance Committee be adopted.—*Carried.*

Just prior to adjournment, Mr. R. H. Starr moved, and Mr. H. F. Shearer seconded, a resolution extending to Messrs. Dobson, Gerrie, and Street, a very hearty vote of thanks for the papers they had presented that morning. This was carried.

At 12.30 p.m. the Association met with the O.M.E.A. for the second Convention luncheon when Mr. R. L. Dobbin acted as Toastmaster. The guest speaker, Rev. John G. Inkster

of Toronto was introduced by Mr. C. A. Maguire, President of the Ontario Municipal Electrical Association.

The third Convention session opened at 2.30 p.m. when Mr. Kirk M. Reid, Director of Street Lighting and Flood Lighting, Engineering Dept., National Lamp Works, General Electric Company, Nela Nela Park, Cleveland, Ohio, gave an address on "Illumination", after which he showed some slides illustrating his talk.

Mr. R. E. Jones, Distribution Section, H.E.P.C. of Ont., read a paper entitled, "Construction Standards", which was illustrated by lantern slides.

Following this paper and as part of the discussion on it, Mr. R. J. McFarlin, Electrical Engineer, Electric Service Supplies Company, answered questions with reference to the installation of lightning arresters.

After extending to the various speakers the thanks of the Association the session then closed.

The Convention Register shows the total attendance at the Convention as 431, distributed as follows :

Class A..........	113
Class B..........	150
Commercial......	91
Associates........	44
Visitors..........	33

There were 482 present at the Convention luncheon on Wednesday, the 29th, and 452 present at the Convention Dinner on the evening of the same day. The attendance at the Convention Luncheon on Thursday, January 30th, was 385.

Minutes of Executive Committee Meeting

The Executive Committee of the Association of Municipal Electrical Utilities met at the Royal York Hotel, Toronto, at 9.30 p.m., on Wednesday, January 29th, 1930. Those present were as follows : Messrs. R. L. Dobbin, President; O. H. Scott, C. T. Barnes, R. J. Smith, J. E. Teckoe, R. M. Bond, J. R. McLinden, J. W. Peart, E. V. Buchanan, T. J. Hannigan, and S. R. A. Clement.

Committees for the year 1930 were drafted as follows :—

Papers Committee:—Messrs. E. V. Buchanan, Chairman; A. B. Cooper, J. J. Jeffery, C. E. Schwenger, C. S. Barthe, and W. R. Ostrom.

Convention Committee :— Messrs. J. W. Peart, Chairman; D. B. McColl W. H. Childs, R. H. Starr, G. F. Drewry, G. J. Mickler, F. Mahoney, H. T. Gibbs, A. S. McCordick, and J. W. Purcell.

Regulations and Standards Committee :—Messrs. R. J. Smith, Chairman; J. R. McLinden, G. E. Chase, J. J. Heeg, E. I. Sifton, W. P. Dobson, and A. G. Hall.

Committee on Accident Prevention and Health Promotion:—Messrs. C. T. Barnes, Chairman; A. L. Farquharson, H. G. Hall, W. E. Reesor, C. E. Brown, C. E. Schwenger, V. McKillop, F. C. Adsett, T. C. James, G. F. Drewry and Wills Maclachlan.

Merchandising Committee:—Messrs. O. H. Scott, Chairman; J. E. B. Phelps, F. S. Rhoads, A. O. Hunt, W. H. Childs, C. W. Burns, I. N. Pritchard, A. B. Scott, R. S. King,

J. J. Heeg, A. B. Manson, H. F. Shearer, and G. J. Mickler.

Rates Committee:—Messrs. J. B. Phelps, Chairman; P. B. Yates, E. I. Sifton, E. M. Ashworth, A. B. Manson, V. S. McIntyre, J. G. Archibald, A. B. Scott, O. M. Perry, and D. B. McColl, and all of the members of the 1930 Executive Committee.

Auditors:—Messrs. W. G. Pierdon and H. P. L. Hillman.

It was moved by Mr. J. R. McLinden, and seconded by Mr. J. E. Teckoe, that the Committees as drafted be approved.—*Carried*.

Mr. James G. Reid, Manager, Bigwin Inn Hotel, was then invited into the meeting, when he spoke on behalf of his hotel for the Summer Convention of the Association. After Mr. Reid had retired Mr. W. A. Stead of the King Edward Hotel was also invited into the meeting, when he spoke with the object of getting the Summer Convention at Niagara Falls, Ontario. It was recognized that the month of June was fully taken up by various Conventions, interfering with the Association, and it was deemed advisable that some later dates be considered, if such could be arranged. Mr. Reid reported that he could arrange to take care of our Convention on July 7th, 8th, and 9th.

It was moved by Mr. E. V. Buchanan, and seconded by Mr. J. W. Peart, that the Summer Convention be held at Bigwin Inn on July 7th, 8th, and 9th.—*Carried*.

It was moved by Mr. E. V. Buchanan, and seconded by Mr. C. T. Barnes, that the Secretary and retiring Treasurer be paid an honorarium of the same amount as in previous years.—*Carried*.

It was moved by Mr. O. H. Scott, and seconded by Mr. J. W. Peart, that the Secretary be instructed to write a letter to Mr. A. W. J. Stewart, retiring President, expressing the regrets of the Association on account of his illness and consequent inability to attend the Convention, same to be accompanied by flowers.—*Carried*.

Discussion turned to the question of obtaining gifts from manufacturers and supply houses for certain occasions, after which it was moved by Mr. O. H. Scott, and seconded by Mr. J. R. McLinden.

> "THAT this Executive recommends to the membership that the O.M.E.A. be asked to circularize their members asking them to discontinue the practice of requesting donations or gifts for picnics, Christmas trees, etc., and accepting gifts of any kind from manufacturers and distributors of equipment and supplies."—*Carried*.

Mr. E. V. Buchanan spoke of Anti-Public Ownership propaganda that was being broadcasted and suggested that something should be done toward broadcasting counter information. Although there was considerable discussion on this question it did not advance sufficiently to permit passing the resolution.

There being no further business the meeting adjourned at 11.30 p.m.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Hydro Accomplishments

By C. A. Maguire, Commissioner, H.E.P.C. of Ont., and President, O.M.E.A.

(Address to Annual Meeting of the Ontario Municipal Electrical Association, at Toronto, January 29, 1930)

GENTLEMEN, I can only say, after concluding my fourth year on the Commission in September last, that it has been most gratifying to me as your representative to see the tremendous advance made by the cause of public ownership in the distribution and generation of power in the Province of Ontario, and the warmth of the reception given to it by the people of Ontario. The past year has been an outstanding one in carrying out the ideals of the late Chairman, Sir Adam Beck, to cover the entire province with a service through our own Public Utilities Commission. We have had the most wonderful co-operation in the organization itself from the engineering staff who were most zealous at all times to render whatever service they could and to do whatever they might be called upon to do to advance the cause.

When you recall, gentlemen, the advances made in this province since the early days, and when you remember that of the 1,800,000 horse power generated and distributed by all parties in the Province that 1,400,000 is being developed by your own Commission, you will realize what a wonderful accomplishment it is.

Through the advances of science your Commission within a very short space of time is going to be able to link up this entire Province so whether the Industrial development be in Western Ontario, Eastern Ontario or Northern Ontario we hope to be able to call upon the surplus of power in any section and throw it in to any other section where it may be required. Twenty years ago that would have been impossible ; but to-day transmission is not an obstacle, as we are bringing power 220 miles from the Gatineau, and about 230 miles from the Beauharnois development.

I know that most of you are anxious to hear something as to the financial

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structure of your organization. I have had some figures compiled and shall give them to you in brief. Investments to-day amount to $315,-432,165. You will remember that last year I mentioned that we had sixty or seventy millions of reserves. To-day we report about $86,000,000. That is a remarkable record, but one that you could readily appreciate if you were on the Commission and saw the demand for power.

Industries are taking advantage of our cheap power and are applying it in a dozen and one new and different ways. When we contracted for the 250,000 horse power of Gatineau power we had to advance the time of delivery. We thought we were covering the needs of the entire province when we asked them to limit their supply over a period of three years ; but the demand is so great that the supply is taken up practically six months ahead of time. We then thought that it was the duty of your commissioners to make a complete survey of the power requirements for the next six years, hoping we would by that time be on the St. Lawrence. We figured up to 1936. Our survey showed requirements 850,000 horse power in the fall of that year. 1930 is on us now, and I would not be surprised if by 1935 we will have absorbed the entire program laid out. There is the Beauharnois with 250,000 horse power, and the Chat Falls on the Ottawa, 50 per cent. owned in Quebec and 50 per cent. in Ontario, which will give us about 96,000 horse power, and an option on some of the surplus power of the private interests on the Quebec side. The Carillon development on the Ottawa will give us about 150,000 horse power. That, with the Beauharnois and other developments we hope will tide us over until 1936. As I have said, however, if the demand continues to increase as it has done it is possible that we will have only a five year supply.

You see the importance of the development of the St. Lawrence in view of the possibility of a power shortage. We have taken advantage of all the power sites available to serve the Province. It is only fair to estimate that it will take at least three years to negotiate a treaty with the United States for the development in the International Section of the river. The development itself will take between six and eight years. Your Commission felt that they would be remiss in their duty if they did not take advantage of all the power they could secure, and it would have been a mighty serious thing for this Province if your Commission had had to report to the local commissions, "We are sorry, but you will have to curtail your power load".

There is one thing that stands out pre-eminently as placing this Province in its present enviable position, and that is the vision and the foresight of out late chief years ago. To realize this you have only to read his remarks on the subject prior to 1924. I had the pleasure of reading some of them at home the other night, and it was amazing to see the way in which he stated exactly what was going to happen, step by step.

Some people have criticized the present Commission for contracting for power. Gentlemen, the bringing into this Province of electric energy from another Province is a real asset in the development of our industries. If there is one thing more than another the Chairman of the present Commission deserves credit for, it is his foresight in bringing about the contract with the Gatineau Company.

We hope that we have power in sufficient quantity until 1936. The engineers made a careful study, and we see a despatch in the Press that indicates that the Cabinet at Ottawa is very shortly going to consider the power question. If that is so, what has been regarded as a very difficult and serious situation will be avoided. There is no difference of opinion. The Hydro-Electric Commission under the leadership of Sir Adam Beck approved and passed on such a system. The engineers appointed by the Dominion Government at one time favoured the one stage system. Sir Adam, of course, contended, and rightly so—and he was backed up by his engineering staff—that the two stage system was more economical. I am glad to report that the engineers of the Commission, the engineers of the Dominion Government, and the engineers of the Canadian section of the Joint International Engineering Board are now unanimous on the two stage system.

Further, the rights of Ontario on the Ottawa River had been recognized. Carillon was difficult because the old Shanly Line, made many years ago, only gave Ontario about ten per cent. of the water ; but through the good offices of the Ontario Government and the recognition by the Quebec Government, the line has been established so as to give Ontario 50 per cent., and Quebec 50 per cent., at Carillon.

That goes further ; it places Ontario in such a position that its rights for Power Development on the Ottawa River will be, I believe, recognized. From this you will see the possibility of completing the scheme of developing power in the east and in the north and extending down to the Georgian Bay system, and linking up with the present Niagara system, so that some day we may be able to transmit the power to any section which may require it.

That is the ideal, and the objective of the Commission. We have cases in which we have been asked for twenty thousand or thirty thousand horse power, and it has been difficult to deliver it because it would have required some new development.

This year your Commission bought the Madawaska development from the O'Brien estate. A private company had an option on it for $2,250,000. They came to us with it, but they wanted too much for it, and we said we would not take it, and the option expired and your Commission

were able to buy the Madawaska with a possible development of nearly 90,000 horse power for $1,800,000. That is a wonderful off peak proposition for us in Eastern Ontario. We then secured the Wahnapitae Power Company of Sudbury. We were criticized in the press for paying so much for it, and I think it is due to you as representatives of the municipalities to tell you the story. The Chairman met a gentlemen in Ottawa representing the majority shareholders who said he and his family controlled the Wahnapitae and suggested that the Hydro Commission purchase the Company.

On his return the Chairman brought the matter before the Commission and we said, "Why not get him and see what he wants for it," this was done and the gentleman submitted his offer, which we thought was a reasonable one, so we secured control of Wahnapitae Company.

Following this the gentleman who represented the Minority shareholders appeared in the Commission Office on the day on which the editorial criticizing the Commission appeared in the Press and I said, to him, "Criticism has been made that we paid your Company too much money for this development." "Well", he said, "Mr. Maguire, I will just sign a letter and I will give you $50 a share above what you paid for it. Now you will have an opportunity of making a million dollars for the Province." I said, in reply, when we buy anything we do not sell it again. We elected him president and told him there would be no more dividends and no more director's fees. He carried on or a few months, and then he said, "I guess I had better sell my stock." The other day we completed the purchase of the Minority Shares of the Wahnapitae.

That is to serve Northern Ontario, but it is absolutely inadequate. We had a big concern come to us and say, "We want 16,000 horse power for our plant and one of our associates wants another 6,000 horse power. That is our immediate demand ; we think that in a short time it will be 50,000 horse power." We have the Wahnapitae development of about 20,000 horse power, and this carries with it a further possible development amounting to close to 80,000 horse power. But where are we to get this 50,000 horse power ? We have made a complete study of the Mississagi River, the Montreal River and the Ottawa River, and it seems to be most economical to serve Sudbury from the Mississagi River, where we have a possible development of 150,000 horse power. With the Wahnapitae development it has become possible to go into that country, and we are told by representatives of the Industries there and those who are going to locate there that they could not possibly establish themselves if our power rates were the same as are charged in the country to the south of us.

What is that going to mean ? It means that millions of money will be invested in this Province for industrial purposes, all brought about by the persistent loyalty of the people of this Province to this undertaking. They have not wavered in the slightest degree in spite of the insidious propaganda that has been carried on in the U. S. and Canada

through professors in the universities and school teachers in the schools. The success of this work is radiating into the country to the south, and industry after industry is coming here and asking for power.

Last night in this hotel I met a gentleman from Pennsylvania who has located out here in the East. He uses only a small block of power. I said, "What brought you here?" He said, "In my line of business this is the only place where I could hope to build up with the aid of cheap power." Every day new industries are coming here because we are able to place the resources of our entire water power development at their service, thanks to the advances that science has made in transmission. If it had not been for the absolute sincerity of the men associated with the late Chairman—and I see some of them here to-day who always believed in Public Ownership, where would the Province be to-day? I said last year, and I repeat it again: Where else in the world can you find such a financial structure as we have in this very organization? Just think of it!

When we met last year I referred to the statement of the Governor of the old State of New York, who said, "The time has come when we must serve rural New York and get power to the farms of rural New York." Up to the end of October, 1929, we served in this Province 37,340 farms. Think of it—building over a thousand miles a year of lines to serve the farmers of this Province. And wasn't I pleased when the Commission which I have the honor to represent unanimously agreed to reduce the service charge to the farmers to a maximum of $2.50. We owed that to rural Ontario, because without rural Ontario there would be no urban Ontario. We have all got to work together, for these great resources were never intended for any one particular section of the country but for the Province as a whole. (Applause)

A year ago we thought that 80,000 horse power was going to be sufficient to take care of our load increase each year. When I tell you that at one time last year the figure went up to 153,000 you will see what a difficult task confronts your Commission. When a customer comes in and wants 25,000 horse power you cannot just go out and turn it on or develop it within the year. Time is necessary. That is why your Commission, knowing that the psychological moment for Ontario was here, took advantage of the opportunities that presented themselves. If we were lax in our duty and had to report that we had not any power where would we have been to-day? Our constant effort is to get power for the Province of Ontario so that we may be able to meet the demands of applicants for power, and therefore our program of 850,000 horse power by 1936 cannot be delayed any longer.

I have every hope that we are going to get action on the St. Lawrence River very soon. The other day there was a conference in that regard. Ontario's rights must be protected. The law says that you must not impair navigation. That is the paramount question with the Federal Government. If we go on a river we must undertake to submit our plans to the Government for approval, so that

power and navigation may go hand in hand. The Beauharnois removed the great obstacle so far as navigation is concerned, leaving only 49 miles of that great waterway to the sea to be excavated and dredged. Is there anything that will do more to bring the East and the West and the Maritimes together than that great highway to the sea with its vast power developments in Ontario and Quebec?

Gentlemen, your efforts and the efforts of your predecessors in this work are bearing fruit. One of the greatest things that we can do as a hydro family is to play our part in raising the levels in that international section by building dams and canals, in that way contributing towards building up Ontario and towards one of the greatest possible works for the general advantage and good of Canada as a whole.

In the Lakes and Harbours Association, of which I am President this year, it has been my privilege to be associated with men representing municipalities in the United States who are just such men as we have in this organization. They are actuated by one desire, namely, to get an outlet to the markets of the world for the products of 40,000,000 people who are locked up in the Western States. When that great seaway is completed we will have made a great contribution to the western farmers. Those are things that are worth while.

Why has the Hydro-Electric system grown so tremendously? It has grown because it has been of wonderful benefit to Municipalities and Industry which are looking for leadership in utilizing what is right at our door. Your Commission has ever been on the alert; there has never been a dissenting voice. We have Government auditors in the office every day. We tell them, "We want you here," because we must stand attacks from every quarter. I am glad to say, however, that the attacks are not as numerous as they used to be, and the reason is that our position is unassailable.

We have people coming here from the United States, from Japan, from England, from all over Europe, and they cannot understand our success. They say, "Do you leave this entirely in the hands of your auditors?" Of course we do. One gentleman from the United States said to me, "In our country the Commissioners would be elected, and the politicians would have control. The auditors would be told, "You are charging too much; this has got to be cut in half." But the law is there, and we want to err on the side of safety, and we are guided by that in our servies to the municipalities. We have had the heartiest co-operation of the Government of this Province because that Government realizes that when we send along our recommendations for expenditures of money they are justified. They may scrutinize our expenditures and consult their advisors, but the Hydro-Electric Power Commission has never been found wanting in anything they have undertaken, and their recommendations have been carried out to the letter. Furthermore, we can say that every dollar that has been advanced to the Hydro-Electric Power Commission has been paid back when due.

Now, gentlemen, I could go on and talk at length on this question, but

I am not going to do so. Last year, owing to power losses between Niagara Falls and St. Thomas we thought that we ought to build a new transmission line. It was built at a cost of one and a quarter million dollars. We said to Mr. Gaby, "That will mean considerable, won't it ?" He said, "Well it means that the saving in the line losses will take care of the charges on the building of that line ; in other words, a saving of over 25,000 horse power." I only refer to this to illustrate the keenness of the engineers on the staff, who are always looking to see where they can effect a saving on behalf of the municipalities of this Province.

The engineers are now at one on the development of the St. Lawrence River, so we hope they will let us get on with the work. It will take six to eight years to complete the development. I hope we will not be out of power for two years after the 850,000 is exhausted in 1936. I understand that someone is going to suggest a resolution on the St. Lawrence development, and I hope they will only have the kindliest references to make and will not in any way reflect upon anybody, because the undertaking is a gigantic one. Governments both Dominion and Provincial have responsibilities, and they have been trying to handle this problem so that there will be the least difficulty.

One of the great difficulties has been in the engineering. It is only two or three weeks ago that the engineers brought in a unanimous report.

We maintain that the water in the International section belongs to Ontario, and that the Dominion Government is interested only in navigation. When you go to the Dominion Government they cannot give you any power rights or anything of that kind ; all they do is to see that your plans do not interfere with navigation, and then they approve of the development. Bearing that in mind, the engineers are unanimous in thinking that we will receive instructions to proceed with the St. Lawrence development, and you can rest assured that everything will be done to get on with the development without any delay.

No public man who is interested in the development of this country can justify himself in lining up with anything that would delay the St. Lawrence development. We have an opportunity at our door and if we take advantage of it there is nothing else that can be undertaken that will be of greater benefit to this country than the development of this power and this highway to the sea.

This was the dream of Sir Adam. I remember when I saw him in the Johns Hopkins Hospital. He had planned then for the development of the north country and of the Ottawa River and the St. Lawrence River. He was a man inspired. He told me of a man upstairs who had 32 transfusions of blood, and he said, "I am going to die, but if I can only have two more years Ontario will be in a most enviable position." Was not that inspiration enough for any man ? The thing that was uppermost in his mind was service to his people though he himself was doomed. Oh, the tragedy of it. Just a year after,

medical science found a cure for the disease that carried him off.

You and I have been entrusted to carry on this work. It is one of the most gratifying things of my life that I was honoured by you in being chosen as your representative to sit on the Commission. To be in that atmosphere is alone worth a great deal to me, because very few have had the opportunity to be honoured in the way that I was, and the only way that I can make any return is to give every ounce that I have in me to carrying on the work you have entrusted to this Commission with which I have been associated since 1925.

The Chairman of the Commission would have been here to-day if it had been possible, but he is in Washington and the Hon. Mr. Cooke, my colleague, asked me to express his sincere regret that a Cabinet meeting made it impossible for him to attend. I never worked with two men who on all occasions showed a more sincere spirit of co-operation with the municipalities. The Chairman always says, "Do you think the municipalities will support that," when a proposal is put before him.

When the question of pensions comes up I hope and trust the Commissions of this Province will take advantage of the scheme and go into it. We owe it to public servants, who through no fault of their own are incapacitated, to look after them. A number of the municipalities are coming in under the pensions scheme now, and I do not think it will be long before they are all in. I believe that any time you can do something for someone else you can go home with the feeling that the day has been well spent ; and I believe that we can justify the Commission in offering its employees the benefits of this scheme, and that we can recommend it as one of the best.

The history of this pension scheme is not going to be a repetition of the history of pensions funds in the past. When I was Chairman of the Police Commission I said, before I left, "I want that pension fund looked into before I leave." It was looked into, and we found that it was insolvent, and the City of Toronto has to make it good. But to-day you are presented with a proposition that should appeal to every Commissioner in the Province. We have had valuable service from our men, and loyalty in the extreme. In the early days when private interests were decrying the ideals of the late Chairman, saying they were only a dream and never to be realized, our men stood by us. I say let us pay tribute to them now and induce them to take advantage of this pension scheme.

I am gratified to see so many here to-day. It is always a pleasure for me to meet representatives of the O.M.E.A. in convention. The spirit that prompts you is the spirit that prompted me for many years. I always say to my wife that if one has done something for the benefit of someone else that when the time comes to shuffle off this old earth he need not feel so badly about it. I am not saying that I want to shuffle off just at present ; (Laughter), it is a privilege to meet gentlemen who are actuated by the same motives. I thank you very much for your patient hearing this afternoon, and as your

humble representative on the Commission I assure you that the watchword is "public service, efficiency and economy," and that the objective is the covering of this entire Province by a publicly owned distribution system. (Loud applause).

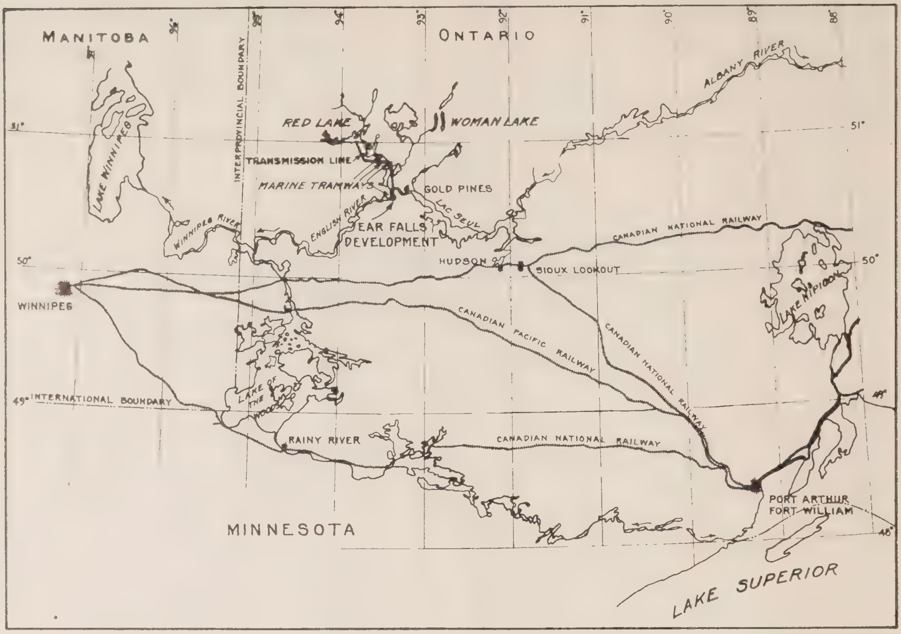
Recent Developments in North-Western Ontario

By F. W. Clark, Assistant Engineer, Hydraulic Dept., H.E.P.C. of Ont.

TO the average resident of southern Ontario the nothern and northwestern sections of the province are places of great promise, but also of great mystery. If anyone will take the trouble to look at a map of Ontario, he will find what a small proportion of the province lies south of an east and west line drawn through North Bay. The vastness of the balance of the province is too little realized, where distances are tremendous, settlement is sparse, and transportation difficult. After one gets away from the railway, thirty miles is a long day's trip, either walking or paddling, as compared with perhaps an hour's driving by motor car over the roads in the southern portion of the province. Aeroplanes provide a delightful and rapid method of transportation, but, as yet, they are rather expensive and their use is restricted to more or less well defined routes. The care taken by the commercial companies to keep their planes in first class condition, and the expertness and carefulness of the pilots, with resulting freedom from accidents, has created a feeling of confidence in this method of travel.

During the past year and a half the Commission has been engaged on the design and construction of several projects in the far northwestern part of the province, more particularly at the outlet of Lac Seul, in what is commonly known as the Red Lake Mining Area of the District of Patricia. Lac Seul is an enlargement of the English River, which is one of the main tributaries of the Winnipeg River. The outlet of this lake is about three hundred miles northwest of the twin cities of Port Arthur and Fort William, and two hundred miles northeast of Winnipeg. By water it is one hundred and twenty-five miles from the railway, and by aeroplane about seventy-five miles. It takes from ten to twelve hours to travel by boat from Hudson on the railway to Gold Pines at the northwesterly end of the lake.

The Commission's activities in this district have consisted of the design and supervision of the construction of the Lac Seul conservation dam at Ear Falls, the design and construction of a power house at the same place, the design and supervision of a system of marine tramways from Ear Falls to Red Lake, and the general overseeing



Map showing location of Ear Falls Development.

of the construction and design of a power transmission line between the same points.

The Lac Seul conservation dam is situated at Lower Ear Falls on the English River, about three miles below the outlet of Lac Seul. It was constructed jointly by the provinces of Ontario and Manitoba ; in the latter case through the Dominion Government, which, until recently, controlled the natural resources of that province. The Commission acted in the capacity of consulting engineers to the Department of Lands and Forests of Ontario, in whose hands all the interests were concentrated.

The purpose of the dam is to regulate and conserve the waters of the English River, to the end that power plants, present and future, on the river below may benefit therefrom by increasing their output more especially during periods when under natural conditions the power supply would be greatly curtailed by lack of water.

Lac Seul has an area of four hundred and twenty square miles, and the storage basin created by the dam is among the largest on the continent. As there is practically no settlement along the shores of the lake, an excellent opportunity was offered for the raising of the water to an elevation which provides 3,300,000 acre feet of storage.

The conservation dam, which is of concrete, is approximately six hundred feet long, and has a maximum depth of forty-five feet to rock. Twenty sluices, having a discharge capacity of over 50,000 cubic feet per second, are provided to handle the flood flow from the lake, and an

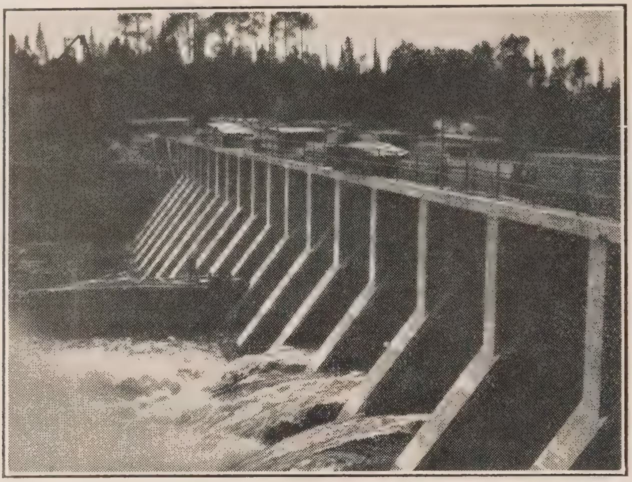
Gold Pines

electrically operated spud winch is provided for the handling of stop-logs for controlling the flow. Work on the dam was begun in August of 1928 and finished in April, 1929.

On completion of the conservation dam, instructions were issued to proceed with the construction of a power development at Ear Falls, and the presence of the Contractor's staff and plant at the site greatly facilitated the work and resulted in considerable saving in transportation and organization costs.

The power plant was built to supply power to the mining fields of Red Lake and Woman Lake. The development consists of a 5,000 horsepower, vertical turbine, of the propeller type, set in a concrete scroll case, and is supplied with water by two 12-foot diameter wood stave pipes

Dock at Ear Falls



The Lac Seul conservation dam at Lower Ear Falls on the English River

each about 140 feet long, connecting with two of the sluices in the conservation dam.

The turbine is controlled by an oil pressure governor provided with electrically driven fly balls and will drive a 3 phase, 60 cycle, 5,000 kv-a., direct connected generator. To avoid unnecessary initial expenditure, the power house superstructure is of frame construction protected with sheet metal both inside and out. A timber gantry crane was provided for handling the generator during erection and maintenance work.

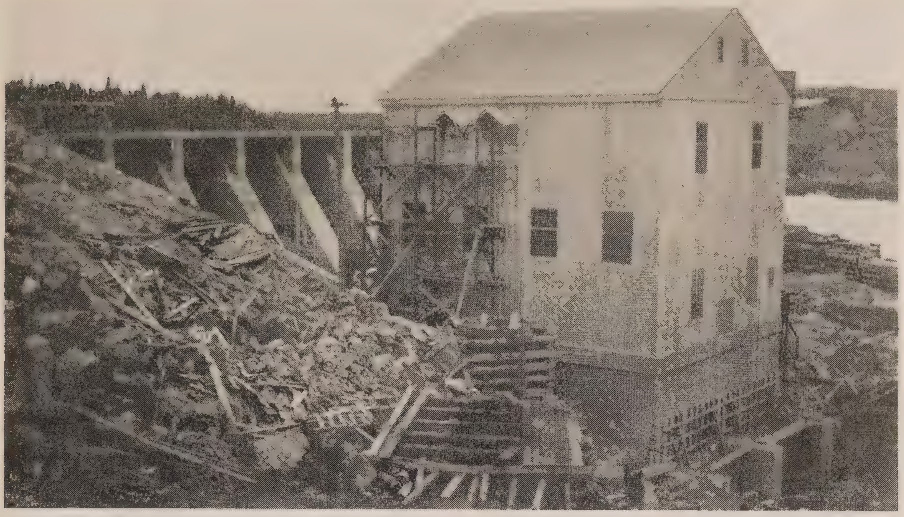
Immediately adjacent to the generating station is located the outdoor transformer station where the current is stepped up from a generator voltage of 6,600 to 44,000 for transmission to Red Lake.

The Ear Falls site is capable of delivering some 30,000 h.p. under full development and in arranging the present work due consideration was given to its co-ordination in the completed development.

Work on the power development was started in May, 1929, and owing to the early closing of navigation about October 1st, it was essential that all equipment and material be delivered at Hudson, Ont., not later than September 15th. This required accelerated schedules, particularly for equipment requiring special development and design.

Simultaneously with the work on the power development, the Howey Gold Mines, Ltd., undertook the building of the transmission line from the plant to the mine at Red Lake, some 40 miles. This line, which was built under specifications of the Commission, is of wood pole H-frame type of construction with suspension insulators. The poles are of local timber and were secured along the route of the line which passes largely through heavily timbered territory.

Work on the power plant and transmission line was completed in December of 1929, and the plant



Ear Falls Power House

made ready for operation by the beginning of the present year.

Contemporaneously with construction of the dam and power plant the Commission, at the request of the Department of Lands & Forests, reported on the possibility of providing aids to navigation between Lac Seul and the Red Lake mining area. As a result of the investigations the construction of a transfer track, three marine railways or tramways, and two small dams was undertaken.

By means of these improvements, freight need only be handled once after leaving the railway at Hudson, Ont. This rehandling is necessary at Ear Falls where the freight is transferred by means of a car and hoist from the large scows operating

Step-up transformer station at Ear Falls

on Lac Seul to the smaller scows used on the lower English and Chukuni Rivers. After passing Ear Falls it was formerly necessary to break bulk and carry the loads over at least three portages, which, in the case of large and heavy pieces was both slow and expensive. With the facilities now provided, the scows when loaded below Ear Falls travel without further unloading to their destination at Red Lake, being handled over the various portages on specially constructed carriages.

By means of these improvements, it is now possible to transport a piece of heavy machinery from Ear Falls to Red Lake in two days, where formerly up to six weeks was required for a similar undertaking and a further indication of their assistance is found in the fact that during the past summer approximately 2,500 tons of freight were handled over this route.

The construction of the Lac Seul Conservation dam, the power development, transmission line and tramway, was carried out by Morrow & Beatty, Limited, Peterborough, and the turbine and governor were supplied by the Dominion Engineering Works, Limited, while the generator and transformers were supplied by the Canadian Westinghouse Co., Limited.

Dominion Power and Transmission Company, Limited, Purchase

THE Hydro-Electric Power Commission of Ontario has just consummated an agreement for the purchase of the entire assets, franchises and rights of the Dominion Power and Transmission Company and its subsidiaries, for the sum of $21,250,000.

The present agreement cannot be said to be only the result of recent negotiation, because the Hydro-Electric Power Commission and the Dominion Power and Transmission Company have had various proposals under consideration for the past ten years. Terms suggested were not mutually agreeable. Delay, however, has afforded the interested parties opportunity more fully to appraise the details of the assets and circumstances involved. The fact that the Company and the Commission have worked for so many years in the same territory as competitors—and the Company was a fair competitor—has resulted in a mutual understanding of common problems and thus has contributed to aid the negotiating parties in finally reaching common ground in the present agreement.

Under the purchase agreement, the Commission is to pay the Company $21,250,000 in bonds of the Hydro-Electric Power Commission, guaranteed by the Province of Ontario, as follows: $8,250,000 par 5-per cent, 5-year bonds; $13,000,000 par 4¾ per cent, 40-year bonds; and, in addition, the Commission is to pay cash for the stores and supplies on hand as of January 1st, 1930, and

besides is to take over all Accounts Receivable and Accounts Payable as adjusted to that date.

The Dominion Power and Transmission Company is the controlling Company, with Head Office at Hamilton, Ontario.

Its Charter was granted under the Ontario Companies Act, on the First of February, 1907, for the purpose of acquiring and controlling the various subsidiary Companies. The Hamilton Cataract Power, Light & Traction Company, Limited, was incorporated on the Fifth of February, 1903, for the purpose of controlling some smaller subsidiary Companies, all of which are included in the present agreement. The Subsidiary Companies are as follows:—

The Hamilton Cataract, Power, Light and Traction Company, Limited.

The Hamilton Electric Light and Power Company, Limited.

The Hamilton Street Railway Company, Limited.

The Hamilton and Dundas Railway Company, Limited.

The Hamilton Radial Electric Company, Limited.

The Hamilton, Grimsby and Beamsville Electric Railway Company, Limited.

The Brantford and Hamilton Electric Railway Company, Limited.

The Hamilton Terminal Company, Limited.

The Highway King Busses, Limited.

The Dundas Electric Company, Limited, Dundas, Ontario.

The Lincoln Electric Light and Power Company, Limited, St. Catharines, Ontario.

The Western Counties Electric Company, Limited, Brantford, Ontario.

Territory and Customers Served

Power has been supplied by the Company in the territory extending from Port Colborne to Brantford and Oakville, and its operations include the following Municipalities:—

St. Catharines, Beamsville, Grimsby, Hamilton, Burlington, Brantford, Grantham Twp., Clinton Twp., North Grimsby Twp., Saltfleet Twp., Ancaster Twp., East Flamboro Twp., Nelson Twp., Burlington Beach.

In addition to these, power is sold to the Municipalities of,—

Smithville, Bronte, Oakville.

The Company also supplies power to large power users, as follows:—

The Maple Leaf Milling Company, at Port Colborne,

Plymouth-Cordage Company,

Canadian-Meade Morrison Company,

Stokes Rubber Company, and

The Maple Leaf Milling Company, at Welland;

The Welland Ship Canal at Thorold,

The Hayes Wheel Company at Merritton,

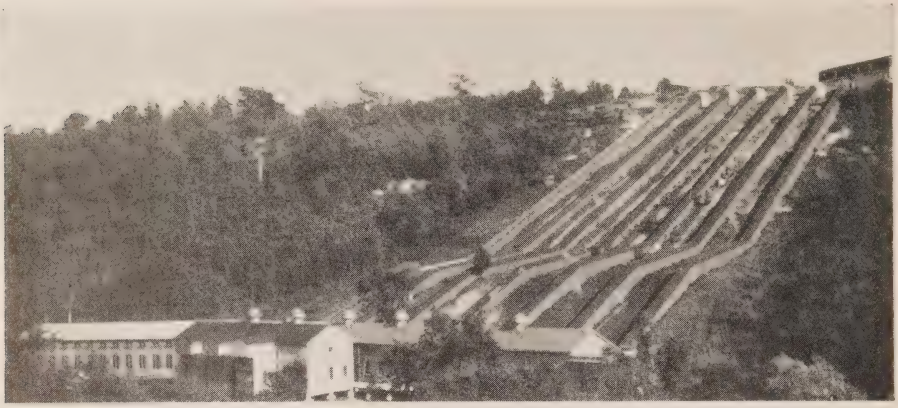
The Dundas Quarry Company at Dundas,

The National Fireproofing Company in East Flamboro Township,

and to numerous small industries scattered throughout the territory served.

Sources of Power Supply

The Company receives its principal supply of power from a hydraulic



Decew Falls power plant

generator plant at Decew Falls, located about two miles from the City of St. Catharines. The water from this plant is taken from the Welland Ship Canal, under long term leases granted by the Department of Railways and Canals. This Decew plant has a capacity of approximately 50,000 h.p. The power from this plant is augmented by a steam plant located in the City of Hamilton, having a capacity of approximately 25,000 horsepower, and, in addition to these amounts, the Company has a long term agreement for the purchase of 10,000 horsepower from the Canadian Niagara Power Company at Niagara Falls, making a total power capacity of approximately 85,000 horsepower.

Power from Decew Falls is transmitted to Hamilton, over four circuits two of which are on steel towers, and from thence to the City of Brantford with two circuits. Burlington and Oakville are served by a single circuit line,—all at 44,000 volts. Short extensions are made from Burlington and Hamilton to the Dundas Quarries and the National Fireproofing Company at 11,000 volts. From Decew Falls power is supplied to St. Catharines over a single circuit 11,000-volt line, as well as to the Welland Ship Canal. The power to Welland and Port Colborne, however, is transmitted at 22,000 volts over a three circuit line from Decew Falls to Welland, and a two circuit line from Welland to Port Colborne.

The steam reserve plant was constructed by the Company in 1918 for the purpose of augmenting its power supply. This plant is modern and has been in continuous operation for the past twelve years, and employed largely for the purpose of carrying the peak load of the system. In 1924, it became necessary to further augment the power supply by contract with the Canadian Niagara Power Company for 10,000 horsepower.

Arrangement for 25 cycles.

Power is supplied from the Company's present power plants at a frequency of $66\frac{2}{3}$ cycles, and in order to co-ordinate these plants

with those of the Commission supplying power to the Niagara system, it will be necessary to remodel the Company's plants so as to operate at 25 cycles. This co-ordination will be carried out over a period of years. In making this change to 25 cycle supply, reasonable consideration will be given to the matter of changing the $66\frac{2}{3}$ cycle equipment of existing D. P. & T. customers so as to cause all as little expense and inconvenience as possible.

Some customers of the Company may entertain concern respecting the proposed change of the system to 25 cycles, but, in this connection, it should be appreciated that to retain the system at $66\frac{2}{3}$ cycles would seriously handicap the Commission in giving good service, as an isolated plant could not compete in efficiency of service with the flexible facilities of the Commission's system with its many generating stations and transmission lines tied together.

In the taking over of other systems, which required the co-ordination of physical equipment in order to give consumers full advantage of the Commission's service, the staff of the Commission has always striven to bring about the necessary changes in such a manner as to avoid injustice and to cause a minimum of inconvenience to all concerned. The consumer is really the one who will benefit from the change, and all the efforts of the Commission will be directed with the object of making these benefits real.

Railway and Bus Lines

In addition to supplying power, the Company has, for a number of years, been operating Electric Railways in the district above mentioned, and is still operating the Hamilton Street Railway, the Hamilton and Grimsby Electric Railway and the Hamilton-Brantford Railway.

In addition to these electric railway lines, the Company has recently purchased and is operating bus lines between various municipalities, extending from Hamilton to Buffalo, Hamilton to Brantford and Hamilton to Burlington.

Hamilton interswitching station, first out-door station in Canada

Arrangements will doubtless be made with the various municipalities now served by the Company and who do not now own and operate their own distribution systems, for the acquirement of the respective local distribution systems, and arrangements will be made for the taking over of the Company's equipment in municipalities now owning their own Hydro System and supplied with power by the Commission. This amalgamation will eventually result in a substantial saving to all consumers in these municipalities.

Duplication of Equipment and Effort to be Eliminated

It should be appreciated that the able business men who pioneered in connection with the development of the Dominion Power and Transmission Company deserve special credit. They began operations when the electrical industry was just beginning to expand in the territory served. The Company's system, as it today exists, has resulted from many and various additions, and in this respect differs essentially from much of the Commission's equipment which has been of more recent design, constructed on a larger scale, and has been able to utilize the more recent advances in the art of electric power supply. It could not be expected that a concern pioneering as the Dominion Power and Transmission Company has done, could have as modern equipment throughout as could an organization that was establishing its equipment under more modern circumstances. It will be recognized, therefore, that the Hydro-Electric Power Commission will find it advantageous to reconstruct and readapt portions of the properties it is acquiring.

It is not the purpose of the Commission to continue the operation of some of these properties in the manner in which they have been operated by the Company. It is proposed, for example, to re-model and enlarge the hydraulic power plant, using the storage facilities available to create a peak load plant of a much larger capacity than at present. The new plant can be operated in conjunction with the various sources of power supply for the Niagara System, in a manner that will add greatly to service ability. Thus the Commission will be able to supply the Niagara System and make more economical use of the water privileges and extensive storage reservoirs controlled by the Company than could be done by the Company itself if operating the development as an isolated plant. Moreover, the large standby plant proposed can be constructed and power developed at a lower cost than from any other source of peak load power supply available for the territory served.

In a highly industrialized area, such as that supplied by the Dominion Power and Transmission Company, much greater economy will result through the elimination of duplicate generating plants, transmission lines and distribution systems, with a consequent reduction in the ultimate cost to the consumers in the municipalities served. This amalgamation, for example, will eliminate one set of poles from streets now served by duplicate systems of the Company and Hydro.

Hamilton steam power plant

HYDRAULIC EQUIPMENT AND POSSIBILITIES

The water rights and hydraulic possibilities of the Company's properties afford special advantages for Hydro Municipalities, because of the special facilities afforded for coordination of all the plants for the purpose of meeting the demand of peak load conditions.

The original Decew development drew its water supply from the Welland Canal at Allanburg, and conveyed it by a long power canal to the headworks of the first section of the development, which included two turbines each having a capacity of 1,500 horsepower. About 1900, the development was enlarged and storage basins were created along the length of the canal. The construction thus commenced was continued for a number of years, and provided the present headworks at Allanburg, through which the water supply for the plant is drawn into the first of these storage basins, known as Lake Gibson. This and the other smaller basins have an aggregate area of about 500 acres. These provide ample pondage to permit the plant to take care of daily variations in the power demand.

The site was well adapted for such a development, as a tributary of the Twelve Mile Creek flowed westerly, parallel with the crest of the escarpment, for almost the whole distance of five miles from the intake at Allanburg to the headworks. The depression through which this creek flowed served as a canal, as well as forming a natural storage basin when the water level at the headworks was raised. It was thus necessary to build relatively low embankments for but a comparatively small distance. The plant, therefore, having no high earth embankments, is free from one of the common hazards peculiar to many storage reservoirs.

The water supply for the city of St. Catharines is drawn through the intake, and just above the entrance to Lake Gibson is separated from the power water and continues through

a separate canal to the settling basins near the filtration plant. Control gates are provided at an excavated channel which connects the lower end of Lake Gibson and the basin immediately above the headworks, and from this latter basin an overflow is provided passing into the Twelve Mile Creek above Decew Falls, and thus protects the headworks from flooding due to high water. The seven steel penstocks are about 800 feet in length and 6½ feet in diameter, and, with the exception of the first one installed, supply one turbine unit each. The first penstock is connected to three main units and a service unit. Of the main units, it is interesting to note that Units 2 and 3 were installed some thirty years ago and are still giving excellent service. They were of Italian design and manufacture and marked a considerable step in advance in the hydraulic power development in this country, as they were exceptionally efficient for units of that period,—in fact, they are still able to compete with some equipment of much more recent design and construction.

As the demands for additional power became insistent, commencing in 1903 and continuing until 1912, six more units of similar design, each having a rated capacity of 6,100 horsepower, were installed. These units, although rated somewhat lower, are capable of developing about 7,100 horsepower each. Their efficiencies also marked a step in advance of those previously installed, and approached within 6 or 7 per cent. of the best results obtained to date. The last addition is the replacing unit installed in 1912. The plant discharges into the Twelve Mile Creek, which, in turn, enters the old Welland Canal between Locks 2 and 3, the water passing thence by the canal to Lake Ontario at Port Dalhousie. There is a considerable fall in the Twelve Mile Creek, and the Company possesses the property whereby an additional development under a head of about 20 feet is possible near the junction of the creek and the canal.

Present-day practice in the selection of hydraulic equipment would probably cause units of a somewhat different type from those installed at Decew Falls to be used, but the greater part of the existing hydraulic plant is highly efficient and in such condition that it is capable of giving many more years of service. It operates under a head of 267 feet, which is exceeded at Niagara Falls by only the Commission's Queenston plant, where the operating head is 305 feet.

Proposed Improvements

It is probable that the Hydro-Electric Power Commission in the course of the next few years, will reconstruct and enlarge the plant. One of the first steps will probably be the replacement of the older portions of the development. The water and head available will justify the addition of new and larger units, with the object of having the plant become essentially a peak load one. The existing water storage basins, with slight improvements, will permit the draft of large quantities of water and the development of substantially larger amounts of power for short periods, in order to aid in carrying

the peak loads on the Niagara System. The demands upon the power development up to the present have been such that the hydraulic plant has been run at high load factors, and peaks in the load have been cared for by the steam plant at Hamilton and from other sources of supply. Provision, however, was made in the purchase of lands for the storage basins to permit the water to be raised above its present operating level. The value of the storage basins would be thereby considerably increased. It is quite possible that eventually the capacity of the plant will be more than doubled.

Former Experiences

This is not the first time that the Commission has dealt with problems involved in the purchase of extensive properties. There was the purchase and subsequent absorption of the Ontario Power Company by the Commission in 1917 at a cost of approximately $22,000,000. Then there was the Toronto Power Company and its subsidiaries purchased in 1920, for approximately $32,000,000. There was also the Electric Power companies interests—now the Commission's Central Ontario System—which was purchased in 1916 at an approximate cost of $8,000,000. These large systems had all to be absorbed in the Commission's systems. Such procedure necessarily took time and patient consideration in order to harmonize conflicting interests. The experience gained in those matters will prove to be of great assistance in the present case, where physical, economical, financial, municipal and other factors are involved.

Application of Hydro-Electric Power to Farm Work

Article No. 20

Another Class 3 Service in Woodbridge R.P.D.

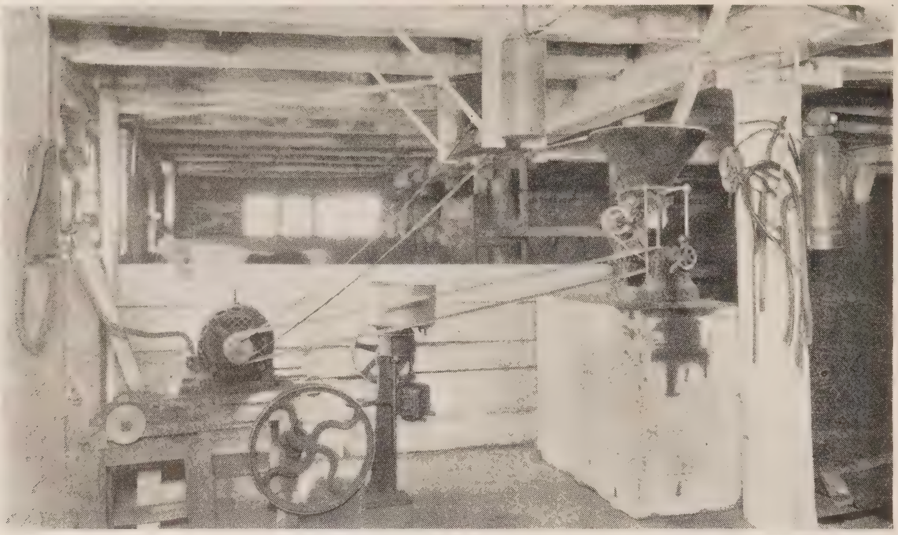
THE James Bernath farm is located just north of Nashville on the Bolton road, and although the lines passing this place were of a voltage from which service could have been given, and existed on this road for a period of about seven years, yet no service was taken until the present owners acquired it, about four years ago. The family, a most interesting and enterprising one, appreciated the benefits of electric service and as soon as possible after making other adjustments on the place installed it. The family consists of Mr. and Mrs. Bernath, two sons and two daughters. The sons are most interested in their herd of throughbred Holsteins, and the animals show the results of the care and attention given them. The influence on social life in the district by this family was very much in evidence both times when the writer called at this place. Mr. and Mrs. Bernath apparently take great interest in church work but the boys are more interested in the needs of the farm, and at the time of the recent call had everything ready to step into the field as soon as the weather was favorable and the land in condition.

The residence on this farm is one of the old type, built of solid brick walls, erected about 60 years ago, spacious and comfortable. The supplying of electric service has added to the comforts of this home.

The fully equipped bathroom.

One of the old-time kitchen coal and wood ranges, with the modern washing machine alongside.

The electric range in the winter kitchen with the sink and three water services, hard, and hot and cold soft water.

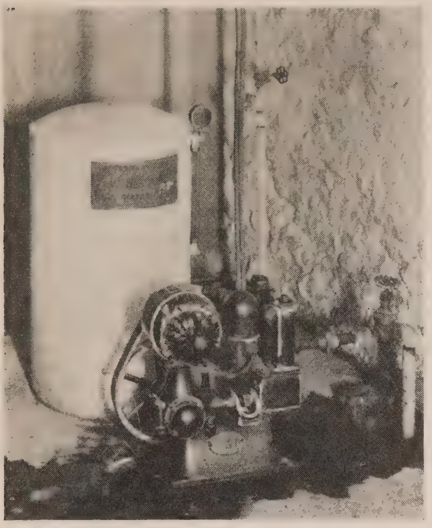


The three horse-power motor in the barn. This motor supplies power for milking, chopping, separating cream, and running the emery stone. The arrangement of the chopper is such as to make this operation almost automatic, a bin above supplies the grain and the chop is delivered into a feed box, thus requiring no attention other than for starting and stopping.

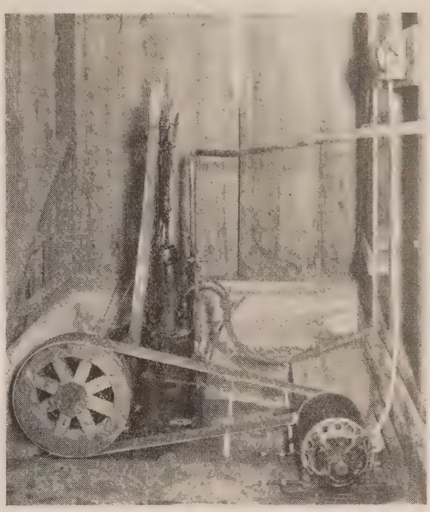
The installation consists of :

Lighting in the house, 21 on 12 switches.........	840 watts
Lighting in the yard, 2 on 4 switches............	200 "
Lighting in the barn, etc., 7 on 2 switches.......	280 "
Total Lighting..................	1,320 "
Electric iron................................	600 "
Electric range (installed in January, 1928).......	7,600 "
Washing machine............................	186 "
Automatic water system for the house..........	125 "
½ h.p. motor on deep-well pump for the barn uses	373 "
3 h.p. motor for driving chopper, milking machine and cream separator....................	2,238 "
Total Connected Load............	12,442 watts

The installed capacity you will note, is approximately 12.5 kilowatts and yet the Class 3 service takes care of their needs, as only a portion of the capacity is needed at any one time. A tabulation of the uses and costs for three consecutive years, with the rates in force, indicates how



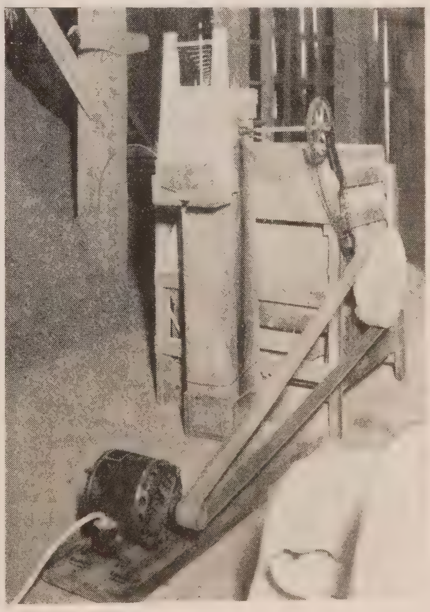
Water service for the house with a 1/6 horsepower motor, self-contained and automatic. This water service supplies soft water only, the hard-water supply coming from the deep-well pump shown in another figure.



The hard-water service for the place. A deep well pump with a half-horse-power motor. Note the hose for washing the milk house floor as well as for washing the car.

the uses have grown from approximately 2,000 kilowatt-hours per annum to 7,340 kilowatt-hours per annum. This in itself is evidence that the service is appreciated and the cost reasonable.

We believe the young men of the district would do well to keep in touch with the uses of electric service on the Bernath farm and to profit by their experience of using power for relieving the family of the irksome duties. At present there are 26 head of cattle, 3 horses and 75 hens for which feed is chopped and prepared. The milking machine is used during the greater part of the year as milking is one of the duties which most of the farm young people today do not enjoy. Light is used to increase production of eggs, a use of Hydro-electric service which is made in



The half horse-power motor from the pump house in use driving the fanning mill.

practically every part of the country today, as it results in a substantial return in the way of greater egg production.

TABULATION OF USES, COSTS AND RATES

Quarter Ending	Consumption Total	Consumption At 2nd Rate	Net Bill	Rates
1927	kw-hr.	kw-hr.		
May 31 (4 mos.)	370	202	$25.06	*Service Charge* — $3.85 per month. *Consumption Charge*—4 cents per kw-hr. for the first 42 kw-hr. used per month ; 2 cents per kw-hr. for the balance used in that month.
Aug. 31	352	226	19.00	
Nov. 30	658	532	24.51	
1928				
Jan. 31 (2 mos.)	668	584	20.47	
For the Year.....	2,048	1,544	$89.04	
Apr. 30	994	868	$30.20	
July 31	1,404	1,278	37.94	
Oct. 31	1,998	1,872	47.52	*Service Charge* — $3.65 per month. *Consumption Charge* — 3.5 cents per kw-hr. for the first 42 kw-hr. used per month; 2 cents per kw-hr. for balance used in that month.
1929				
Jan. 31	1,535	1,409	39.19	
For the Year.....	5,931	5,427	$154.85	
Apr. 30	1,528	1,402	39.06	
July 31	1,858	1,732	45.00	
Oct. 31	2,020	1,894	47.92	
1930				
Jan. 31	1,935	1,809	45.41	—*Service Charge*— $2.78 per month, (for January only). *Consumption Charge*—3 cents per kw-hr. for the first 42 kw-hr. used per month ; 2 cents per kw-hr. for the balance used in that month.
For the Year.....	7,341	6,837	$177.39	

Notes on Grounds and Ground Testing

By W. B. Buchanan, Testing Engineer, H.E.P.C. of Ontario

THE past few years have brought forth a great deal of discussion of grounds and ground resistances. Most of this discussion is correct, within certain limits which may be assumed but not acknowledged by the submittor, and it is the purpose of the present article to outline the subject so that the various views presented may appear in the proper relation to the entire subject and less contradictory to one another than they occasionally have done.

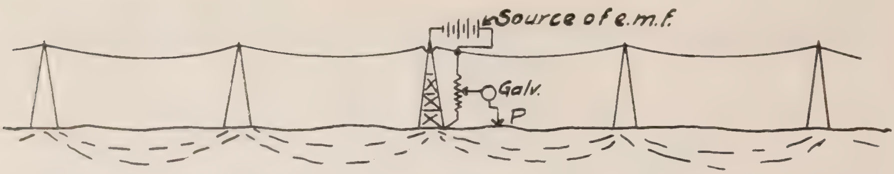
The term "ground", as we propose discussing it, means the connection electrically of any otherwise insulated conductors to earth and includes such soil resistance, etc., as may be necessary to include for the purpose of the study. In many cases it is customary to tie a system to water-pipes and call this connection a ground, but in general it is not permissable to assume the water-pipes as having ground potentials at all times, and our present definition includes also the resistance of the water-pipes and their own earth potential drops as well.

The range of values that may be obtained is roughly from one or two one-hundredths of an ohm, up to between five and ten thousand ohms ; the former value representing the net results of a transformer station site of about ten acres extent, all structures heavily bonded ; the latter being obtained from ground-rods driven in light sandy or gravelly soil.

A typical ground circuit is one of the most complex ; for instance, current enters ground through a driven ground-rod or by a buried conductor ; the cross sectional area of current-carrying path is not uniform, the specific resistance of the conducting medium is seldom constant, and as a result we have an unlimited variety of paths in series and in parallel which can be estimated approximately in only a few of the simplest cases.

Then again the distance which may be assumed to include any definite percentage of the true resistance required will vary with the area of the ground electrodes ; for three-quarter inch pipe grounds there may be ninety per cent of the ground resistance within thirty feet of the terminal, while in case of sub-station grounds of large area, it may be necessary to include several hundred feet distant to obtain one half of the total ground resistance.

The purpose for which test results are to be used also dictates to a considerable extent the method of test and the testing equipment. Protective measures are adopted for example when lightning rods are grounded, when distribution circuits are grounded to protect consumers from possible hazards due to lines contracting with higher voltage. In such cases a purely local value of resistance is required and the tests may be simple for, since seasonal variations are likely to be of the order



Scheme used during 1928-29 to determine the fractional part of a tower footing resistance which would be involved when measuring the current to ground due to lightning disturbances on the line. Measurement of lightning discharges was made by means of Klydongraph plates connected between the foot of the tower and a point indicated by "P" at some thirty to fifty feet from the foot of the tower.

of fifty per cent, a high degree of accuracy is not warranted. Further, the distribution of direct current through ground as occurs with d.c. railway systems is not of the same nature as alternating ground currents with consequent difference in effective values of resistance over considerable distances.

Line impedance tests made for the purpose of engineering design and impedance-distance relay data give rise to another aspect of ground resistance, and this is altered again by the use of overhead conductors grounded at each pole or tower. Tests tend to indicate that at no part of the circuit can the ground resistance and reactance be considered as negligible, but that the ground must be treated as a continuous conductor.

It will thus be seen that a great deal of confusion may arise if anyone undertakes seriously to treat ground resistances as "lumped" values. In a great many cases it may be quite satisfactory to do so, but the assumption should always be carried in mind and waived immediately when test results do not appear to be consistent.

The type of conductor under test is also worthy of some consideration. Normally the soil owes its conductivity to the presence of moisture with, in some cases, some acid present and otherwise varies from dense clay (hard-pan) and rock to light sandy and gravelly soil with little or no moisture in it. Water increases in conductivity very rapidly with increase of temperature, approximately 2.5 per cent, per degree Cent., but also evaporates at 100° C.; hence we can have the phenomena of the apparent resistance reducing rapidly to a certain minimum value, then rising indefinitely during a single test, and all the results correct. This may occur when heavy currents are fed into a driven rod or pipe ground of small area. Such a test also has merit in indicating the permanent current carrying capacity of the ground connection which may in many cases be as vital a matter as a knowledge of its initial resistance.

Within the last few years one of the large manufacturing companies, by using the cathode-ray oscillograph, has made tests of the effective resistance of grounds when taking care of artificial lightning discharges. In all cases this effective value was considerably less than that read by low voltage and small currents in general ranging from thirty to sixty per cent of the latter.

The reason for such a variation might be attributed to the fact that normally soils are somewhat porous

and the application of higher voltage results in a larger area of effective contact between particles due to the shorter air-gaps breaking down. This can most easily be seen by observing a test on soap-stone with gradually increasing voltage. The value of this data in the present discussion is to show that the values obtained under low voltage and low current tests are (except for the drying out phenomena mentioned) safe values to use because they represent the highest value likely to be active under normal conditions.

Some serious consideration must be given to the choice of method of test. As previously pointed out the purpose for which the results are being obtained will dictate to some extent the method that should be used. Impedance-distance tests suitable to check line performance and relay settings demand tests with fairly heavy currents at normal line frequency. For less exacting requirements more latitude may be admitted and in the limiting cases it may be permissible to guess the value of a ground resistance, providing the guessing be done by someone of some experience with that type of ground.

When consideration is given to the use of one or more of the smaller devices on the market for measuring ground resistance, it is advisable to consider certain extraneous influences to which such a meter might be subjected ; *viz*, stray currents either direct or alternating current and electro-chemical e.m.fs. In some cases stray currents may be quite heavy, sufficiently so to damage the movement in a sensitive indicator or to render its readings meaningless ; while in other cases almost any scheme measuring resistance accurately would be satisfactory.

When it comes to a discussion of meters available and their relative merits, prudence dictates discretion. The writer has no commercial interest in any of the instruments now on the market and much prefers to let each be considered on its own merits aided of course by the respective salesman ; hence, the discussion of this part of the subject will be limited to a few points which have given rise to controversy.

We may assume at the outset that any of the types of instruments we may discuss provide their own source of potential and will measure the correct value of a lumped resistance with sufficient accuracy if within its range. This is the most common method of checking a meter, and as the requirements are not very exacting some very crude pieces of apparatus can be made to present a fairly creditable performance. Whether this really represents what is required in service is a more complex matter as previously explained.

Direct reading, direct current meters of suitable range will detect stray currents and if necessary reversed readings may be taken and a sufficiently accurate estimate of the resistance be made without difficulty. Likewise, electro-chemical e.m.fs. which may be set up by using two dissimilar electrodes ; *e.g.* a copperweld ground rod against a galvanized steel tower footing or grillage, may be detected and a correct value of ground resistance obtained. The areas of ground electrodes are usually so large that polarization during the time of test has a negligible effect on the

resistance involved. The effect of stray alternating currents may be screened out by the use of a meter having sufficient inertia in the moving element to keep needle-vibration down to a working condition though the resistance should be high enough that the coils be not burned out. Direct-current meters, however, which depend on a bridge method of balancing resistances offer some difficulty in interpreting results correctly where stray currents or electro-chemical e.m.fs. are prevalent ; in fact, it is so difficult that a bridge method should not be used for measuring the resistance where either stray direct current or electro-chemicale e.m.fs. are present.

Alternating current meters, of course, are sensitive to stray alternating currents and also to direct currents unless isolated therefrom by transformer coupling and suitable precautions must be taken in their design and use to have them give as true readings as possible. Inductive reactance also comes into play at the higher frequencies and limits the universal application of methods using the audio-frequency range.

The three-point method of checking ground resistance has been, and probably will continue to be popular, and if the resistances were really concentrated at the terminals the results should be reasonably correct. However, when the value required is say one per cent. of the value of either auxiliary ground, the results cannot be considered as being very satisfactory.

A more satisfactory scheme which is applicable even in the latter case is to measure the ground under test and the auxiliary ground in series, and by means of some modification of a slide wire and a test probe divide the value obtained in the proportion of the two grounds ; moreover, this scheme can be used in a variety of ways using either direct or alternating current. The slide-wire feature may be dispensed with entirely in some types of tests such as have been used for measuring the resistance of transmission line tower footings, and the major difficulty then lies in obtaining a connection at the desirable point in the circuit.

The Russians have a new popular name for their babies, says the Lowell, Mass., *Sun*. For a time after the Bolshevik revolution, the *Sun* explains, patriotic Russian parents named their children "Revolutzia" to signify their faith in the Soviet upheaval. Electricity, however, has brought them so many comforts that they have taken to naming their children "Electrificatzia," which means "Electrification."

Water Power Resources of Canada

(Excerpts from Bulletin No. 1361 of the Dominion Water Power and Reclamation Service, Department of Interior, Canada)

THE fortunate occurrence of about 60 per cent. of Canada's total water power in the highly industrial, but non-coal producing provinces of Ontario and Quebec, the close proximity of water powers to the mineral and pulpwood areas throughout the entire country and the fact that nearly all of our centres of population have water power within easy transmission distance are circumstances which combine to provide a market for power in which increases in supply barely keep pace with the demand.

With the installation during the past year of new water power equipment totalling almost 378,000 h.p., there is now installed for all purposes a total of 5,727,162 h.p. and by the completion of work now under way this figure will be increased to more than 6,075,000 h.p., before the end of 1930, while an additional installation of over 3,000,000 h.p. is in active prospect.

The installations of the past year are not confined to a particular section of the Dominion, but extend from coast to coast, a statement which applies with equal truth to the many developments in active prospect. An outstanding feature of present day hydraulic development is the large proportion of the power installed for distribution to the public through the medium of central electric station organizations, over 98 percent of the 1929 installation being so installed.

While complete information regarding Canada's water power resources is not yet available all existing stream flow and power data from federal, provincial and private sources have been systematically collated, analyzed and co-ordinated with the object of presenting a dependable estimate of available power based on uniform methods of computation and arrangement.

Basis of Computation

The figures for available water power are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration, is definitely established or at least well authenticated.

The power estimates have been calculated on the basis of 24-hour power at 80 per cent. efficiency for conditions of "Ordinary Minimum Flow" and "Ordinary Six Months Flow". The "Ordinary Minimum Flow" is based on the averages of the flows for the two lowest periods of seven consecutive days in each year, over the period for which records are available. The "Ordinary Six Months Flow" is based upon the continuous power indicated by the flow of the stream for six months in the year. The actual method to determine this flow is to arrange the months of each year according to the day of the lowest flow in each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the ordinary six month flow for

that year. The average of such figures for all years in the period for which data are available is the ordinary six month flow used in the calculation.

Estimates of power on the basis of ordinary six month flow are made upon the assumption that it is good commercial practice to develop wheel installation up to an amount, the continued operation of which can be assured during six months of the year, with the deficiency in power during the remainder of the year provided from storage, by interconnection with other plants on streams of different regimen or operating under different load conditions, or by the installation of fuel power plants as auxiliaries.

Total Available and Developed Water Power

The known available water power in Canada, from all sources and within the limitations outlined, is 20,347,400 h.p., for conditions of ordinary minimum flow and 33,617,200 h.p. ordinarily available for six months of the year.

The conservatism of these estimates is illustrated by an analysis of the water power plants scattered from coast to coast concerning which complete data are avilable as to turbine installation and satisfactory information as to stream flow. The analysis shows the average machine installation to be 30 per cent. greater than the ordinary six-month flow power. Applying this, the figures quoted above, therefore, indicate that the present *recorded water power resources* of the Dominion will permit of a turbine installation of about 43,700,000 h.p.

The total installation to date in water wheels and turbines throughout the Dominion is 5,727,162 h.p. In other words the present turbine installation represents only slightly more than *13 percent* of the recorded water power resources.

Utilization of Developed Water Power

The diversity of utilization of water power and particularly of hydro-electricity is such as to render difficult any definite classification of the ultimate use of the power from sites other than those developed for specific industries such as the manufacture of pulp or paper, or for mining purposes while even in those special industries some part of the power is likely to be diverted for domestic or commercial use. As a very large proportion of the total power developed is distributed through the medium of central electric stations and much of it sold wholesale by the generating stations to other stations the difficulty of a complete analysis as to use is apparent.

It is proposed herein to divide the total installation of 5,727,162 h.p. among the three main classes of central electric stations, pulp and paper mills and other industries and also show the total installation per 1,000 population in Canada.

4,817,486 h.p. or 84.1 per cent. of the total is installed in central electric stations for general distribution for domestic, municipal and commercial use. A considerable proportion of the power generated by this installation is sold en bloc for the manufacture of pulp and paper, for the mining and

reduction of minerals and for electro-chemical production.

578,826 h.p. or 10.1 per cent. of the total is installed in the power plants of pulp and paper mills. The industry also purchases some 860,000 h.p. of electrical energy from the central electric stations for power purposes together with a considerable quantity of off-peak or surplus power for use in electric boilers.

330,850 h.p. or 5.8 per cent. is installed in general industrial plants such as mines and mineral reduction works, electro-chemical plants, saw, grist and grinding mills, machine shops, municipal pumping plants and for electric railway operation.

The total installation for the Dominion averages 584 h.p. per 1,000 of population, a figure which places Canada among the leading countries of the world in per capita utilization of water power.

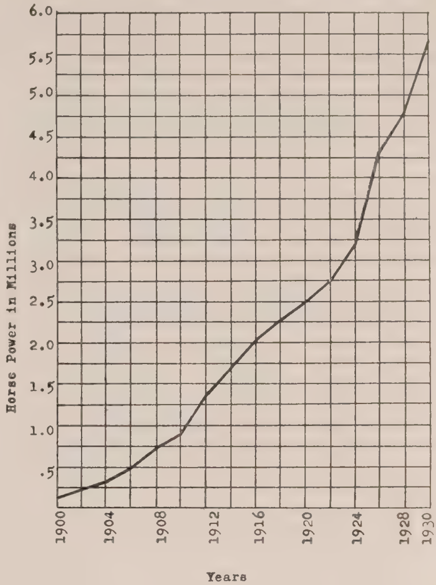
Past and Future Growth in the Utilization of Water Power

The growth of water power development in Canada has been most striking, as shown in the diagram hereunder. Total installed horse power has grown from 890,489 h.p. at the beginning of 1910 to 5,727,162 h.p. at the beginning of 1930, central electric station installation from 586,502 h.p. to 4,817,486 h.p. and pulp and paper installation from 115,042 h.p. to 578,826 h.p. in the same period.

Capital Invested in Water Power

The capital invested in water power development in Canada, inclusive of transmission and distribution systems is estimated to be almost $1,302,000,-

Diagram showing
Growth of Water Power Development in Canada



000 and of this over $1,100,000,000 or 85 per cent. has been expended on land, buildings, plant and equipment. This is greater than the capital investment of any other manufacturing industry and is an investment with a most creditable record of steady earning power as illustrated by the dividend records of its securities and the large increases over a period of years in the output and gross revenue per dollar of investment and in the electrical output per installed horse power.

Applying the present investment per installed horse power to the estimated future growth of hydraulic development it would appear that an average of over $90,000,000 per annum of new funds will be required to finance the developments of the next few years. The ease with which the necessary capital has been secured for previous development and the

satisfactory returns on such investment to date indicates that any reasonable investment demand will be met.

Coal Equivalent of Developed Water Power

The development of water power in Canada has had a direct and very great effect in reducing the consumption of coal and while it is very difficult to assign a precise figure of the coal equivalent of developed water power as the matter is comparative only and assumptions dependent upon the conditions under which the power is developed must necessarily be made, however, taking into account all present conditions surrounding water power development in Canada and comparing them with somewhat similar conditions of fuel development elsewhere it is reasonable to state that a saving of coal of five and three-quarter tons per annum is capable of being effected by each installed horse power. This means that the total present water power installation of 5,727,162 h.p., if operated continuously, is capable of effecting a saving of 33,000,000 tons of coal per annum.

The actual saving in any year is dependent upon the output from the installation and for the year 1929 an approximate estimate of the output expressed in electrical units indicates a total figure of 20,500,000,000 kilowatt hours. Applying to this a conservative figure of 1.76 lbs. of coal per kw-hr., (the average coal consumption per kw-hr. of all public utility electric power plants in the United States during 1928) indicates an actual saving for the year 1929 of 18,000,000 tons of coal.

Better Public Speaking

That the engineer needs to be well versed in the art of presenting his case before an audience would seem to be self-evident in these days of radio broadcasting, financial drives and reporting to city councils, says Engineering News Record. Even the young engineer in presenting an idea to his squad boss in the drafting room needs to be skilled in marshalling his ideas if he would be convincing. With a view to fostering public speaking by the engineer the educational committee of the Associated Technical Societies of Detroit has assisted in forming an intercollegiate engineering debating society. Seventy engineering students at the University of Michigan debate or "wrangle" once a week, under competent guidance. Debates have been held with other institutions. In addition to the engineering students at Michigan those at Detroit Institute of Technology, Nothwestern, Michigan State College, Ohio State University and Purdue University have become interested in the movement looking toward a tournament of debates on engineering subjects. No form of campus activity will net better results to the participants. Listening to engineering society presentations may yet become a pleasure.

—*Daily Commercial News*

Hydro News Items

Central Ontario System

On April 1st the Municipality of Napanee assumed ownership of its distribution system and is now operating under a cost contract with this Commission. The local system is being operated by a Public Utility Commission.

* * * *

For many years an effort has been made to promote a rural district in the vicinity of Stirling, but only one mile of line was built. Under the new rural rates, 25 miles to serve 80 consumers will be constructed during the spring.

* * * *

The beneficial effect of the new rural rate is also seen in Trenton Rural Power District, which has been very slow in developing. 32 miles of line to serve 111 consumers are now under construction.

* * * *

The Municipality of Deseronto is having all necessary documents prepared with a view to purchasing the local distribution system and operating under a cost contract.

* * * *

The Field Farm Milling Co. have taken over the old Pakenham mill in Norwood and have signed a contract for 100 h.p. and expect eventually to use 250 h.p.

* * * *

Addition of 11 miles of rural line will be made to Belleville Rural Power District to serve 56 consumers in the village of Shannonville and vicinity.

* * * *

Georgian Bay System

The purchase of the Foshay Company properties in Bruce County by the Commission has been arranged for and the final details, including certain legal formalities, and the value of Stores, Inventories, and Accounts Receivable are being rapidly adjusted. It is anticipated that the Commission will take over the active control of these properties on or before June 15th, although the date of purchase was set by the agreement as "March 31st" ; in the meantime, the Company's staff will operate on behalf of the Commission under the jurisdiction of the Receiver until all legal and Accounting matters have been adjusted. The deal brings under direct control of "Hydro" the municipalities of Wiarton, Hepworth, Southampton, Port Elgin and Walkerton, and indirectly the municipalities of Mildmay and Formosa, as well as the rural sections throughout the entire County of Bruce and completely eliminates any further controversy with regard to electrical service in that section of the Province.

* * * *

The 110 kv. transmission line between Kitchener and Hanover has been completed, the construction of which was carried on throughout the

winter and the installation of the 5,000 kv-a. Frequency Changer Station at Hanover is progressing. It is expected that this Station will be completed and placed in operation during the month of June, after which time the future supply of power for the Eugenia section of the Georgian Bay System is fully assured.

* * * *

The transmission tie line between the Big Chute Development and the Bala System at Bala is nearly completed. Three 150 kv-a transformers are being installed at Bala to provide for transformation to the Bala System voltage and it is expected that this line and station will be placed in operation about June 15th.

* * * *

Work instructions have been issued and construction work begun on 15½ miles of three-phase line from Utterson to Windermere in the Muskoka district. Work instructions have also been issued covering the construction of a distribution system in the Village of Windermere. Arrangements are being made to have this line in service and power delivered to consumers in Windermere by July 1st. The new substation at Utterson will serve this section.

* * * *

New substations are being installed at Painswick about two miles south of Barrie to supply the south section of the Barrie Rural Power District—capacity 300 kv-a. ; at Fergusonvale to supply the Elmvale Rural Power District—capacity 50 kv-a. ; and at Utterson to supply a part of the Lake of Bays and Muskoka Lakes district, including Windermere—capacity 300 kv-a.

* * * *

Three 1,000 kv-a. transformers are being installed at the Barrie substation replacing four 250 kv-a. Scott-connected units, and arrangements are being made to change the Barrie Distribution System from two-phase to three-phase. The substation at Fennel's Corners serving the Innisfil Rural Power District is being enlarged from 100 kv-a. to 450 kv-a. Three new 250 kv-a. units are being installed at the Chesley substation, replacing three 150 kv-a. units, and the three 150 kv-a units now at Chesley are being installed at the Kirkfield substation replacing three 75 kv-a. units.

* * * *

Work Instructions have been issued and arrangements made to begin the construction of approximately twelve miles of line in the Elmvale Rural Power District involving service to Hillsdale and Craighurst and adjacent farming areas ; of approximately thirteen miles of line on the south shore of Kempenfeldt Bay between the new Painswick substation and Big Bay Point serving farmers and summer consumers in that district ; and also for constructing seven miles of line out of the Utterson substation to serve the summer district in the vicinity of Port Sydney, the hamlet of Utterson and also the district adjacent to the Royal Muskoka Hotel. Arrangements are also being made for the construction of approximately 49 miles of line in the newly formed Hawkestone, Ripley, Thornton and Midland Rural Power Districts. Extensions of existing rural lines are being arranged for, comprising approximately 46 miles.

Madawaska System

Changes in the transmission line from Calabogie to Fitzroy Harbor to serve the Chat Falls construction load have been completed.

As a result of this line it is expected that the Village of Fitzroy Harbor will receive service.

* * * *

A new outdoor substation is being built in Arnprior on account of the growth of load.

* * * *

Interest in rural service has extended to farmers around Renfrew.

* * * *

Niagara System

By the end of 1930, only a few sections of the rural area around Welland will remain uncovered by Hydro lines. Sixty miles of primary line will be built during the present year, making a total of 243 miles of line in operation to serve 2,350 consumers of all classes. By the time this programme is completed less that 125 homes in the entire area will be without a Hydro line passing their door and these could all be served by the construction of a further 30 miles of line.

* * * *

Rehabilitation of the Windsor, Essex and Lake Shore Railway (Sunshine County Route) is going forward rapidly. Hydro power is being supplied from a substation at Maidstone and the steam plant is shut down. Additional substations are being erected at Cottam, Ruthven, and Maidstone, but will not be in operation until the road is changed over from 6,600 volt, single-phase, 25 cycles, to 600 volt direct current.

* * * *

On March 1st, 1930, Sandwich Rural Power District staff moved to a new office at the southerly limit of the City of Windsor, corner of Church Street and Tecumseh Road. The new buildings is equipped with every facility for handling the rural operation and its location is nearer the centre of the rural power district than the former office, which is in the business section of the City of Windsor.

* * * *

The Hydro-Electric Commission of Hespeler has ordered one 1,500 kv-a., 13,200/4,000 volt, 3-phase transformer, and necessary equipment, to replace three 170 kv-a., and three 100 kv-a. transformers. The station is being arranged to provide for a second 1,500 kv-a. transformer. This change is necessitated by immediate additional loads and provides for future growth.

* * * *

Plans are now complete for a new 4,000-volt substation near Thorold to take care of the rural load in that vicinity, particularly west of the town where the growth of load is most notable. The new station which will be known as Beaver Dam D.S. will be of 450 kv-a. capacity, outdoor type, and is expected to be in operation by May 15th.

* * * *

Temporary power from Kingsville Rural Power District was supplied a farm drainage pump on Point Peele to operate a 30 horsepower motor on account of break-down of the gasoline engine. When the Spring season is over it is expected a permanent installation will be made of a low head

turbine pump direct connected to a 20 horsepower motor.

* * * *

The very rapid growth in load at Grand Bend in the Exeter rural district has necessitated changing the distribution system from 3-phase, 4,000 volt, ungrounded to 3-phase, 8,000 volt, grounded. A 13,200/8,000 volt, distribution station, will be installed at Dashwood to serve this western part of the Exeter Rural Power District.

* * * *

The system of the Guelph rural power district originally was fed from the primary system of the Guelph Light and Heat Commission. On March 28th the work was completed of extending the rural primary circuits back to the main station and the entire rural system is now fed directly from its own station feeder.

* * * *

The distribution system of the Georgetown rural power district, which formerly received its power supply from circuits of the Georgetown Hydro-Electric System, is now fed directly from a separate feeder in Georgetown station, the change having been completed on March 29th last.

* * * *

A large gravel plant is under construction in Burford township southwest of the village of Burford and 1,400 h.p. has been contracted for. An electric suction dredge will be employed to remove the gravel.

* * * *

A meat-packing plant located at the west limits of Brantford, which has not been in operation for a number of years, is being reopened as a vegetable and fruit-packing plant requiring 50 h.p.

* * * *

An office with Superintendent and staff has been opened at Oil Springs to operate the villages of Oil Springs and Brigden along with the operation of the Oil Springs Rural Power District.

* * * *

The Town of Strathroy is contemplating the installation of an ornamental street lighting system of twin unit standards on Front and Frank Streets during the coming Summer.

* * * *

The Township of Houghton has signed the agreement providing for rural service in the township making the 267th township to sign for rural service.

* * * *

An additional 4,000-volt feeder is being installed in the Elmira D.S. to eliminate the overloading of the present feeder.

* * * *

A stone quarry has recently started operations approximately three miles west of Cayuga, requiring 175 h.p.

* * * *

A co-operative cold storage plant is projected for the town of Simcoe and will require 100 h.p.

* * * *

Rideau System

Considerable interest is being shown by Summer residents around Rideau Lake with a view to receiving service from Smiths Falls Rural Power District.

* * * *

Street lighting is being installed in the Village of Delta and it is

probable that Portland and Elgin will also be lighted.

* * * *

St. Lawrence System

Sufficient contracts have been received to require a 15 mile extension in Brockville Rural Power District to serve farmers and summer cottagers around Rockport and Ivy Lea and it is expected that this line will be in operation early this Summer.

It is also expected that the line serving Lansdowne will be continued to the eastern limits of Gananoque.

* * * *

Street lighting has been installed in the Villages of Lansdowne and Lyndhurst and negotiations for street lighting are proceeding in the Villages of Lyn and Mallorytown.

Modern Progress or the Pandora Box of Mechanical Invention.

The *Missouri Utility News* says that a guest at a recent demonstration illustrating laboratory achievements by electric and telephone engineers was amazed when :

He "heard" a picture of President Herbert Hoover.

He heard a speechless man "speak".

He saw a deaf man "hear".

He heard the power of 500,000 times 50 strong-lunged men's voices shout the words of one man.

He heard his muscles move, with a sound like thunder.

He telephoned his photograph.

He learned it is possible to gaze at a scene many miles distant.

He heard speech "scrambled" as a cook scrambles eggs.

He heard the top third, bottom third and centre third of a strain of music.

He danced to "upside down" music and heard speech "upside down" and "right side up" at the same time.

He was looked over by electric eye.

He saw and heard speech "take a rest" on the route from lip to ear.

He talked into a telephone and then walked over to the other end of the line and listened to his own words four seconds after speaking them.

He heard the music continue after a phonograph record had stopped playing.

"Such is modern progress," says the *Utility News.* "Many of these things may be commercially perfected within a comparatively short time. Indeed, it may be possible for us to sit in our homes and enjoy some of these remarkable developments a few years from now."

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Ottawa Transformer Station

By E. S. Frost, Municipal Eng. Dept. and G. F. Simson, Electrical Eng. Dept., H.E.P.C. of Ontario

THE City of Ottawa was one of the Ontario municipalities which at an early date, after the Hydro-Electric Power Commission of Ontario was established, made application for a supply of power.

Due to the location of the city, apart from the other municipalities being supplied by the Commission, it was necessary to arrange for a separate power supply and in 1907, the Commission entered into a contract with the Ottawa and Hull Power Company for a supply of power to Ottawa. The contract was for 1,500 h.p. to be delivered at 2,300 volts, with provision for an additional 1,000 h.p. This power was generated in the power-house of the Ottawa & Hull Power Company situated on the Quebec side of the river below the Chaudiére Falls.

There were two private companies distributing power in Ottawa, and the city arranged for the purchase of one of the distribution systems, which has been developed into the Ottawa Hydro Electric System.

By 1910, the full amount of power, provided under the original contract, was being used, and a new contract was entered into between the Provincial Commission and the Ottawa and Hull Power Company, providing for 4,000 h.p. to be delivered at 11,000 volts. In 1913, this supply being used, a new contract was executed providing for a maximum of 20,000 h.p. For up to 5,000 h.p. the price of power was $14.00 per h.p. per year, decreasing to a price of $11.00 per h.p. per year, when 18,000 h.p. or more was taken.

A large portion of the power sold for domestic use in Ottawa, now costs less than one-half cent per kilowatt hour, so that electricity is made the cheap "ready servant" in the Ottawa home.

The load on the municipally owned system has been growing at approximately 2,000 h.p. per year.

By 1929, the load was approaching

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20,000 h.p. and the Ottawa Commission requested that arrangements be made for an additional supply of power. At the same time, it was necessary for the Provincial Commission to provide for the requirements of other municipalities in Eastern Ontario. These have been taken care of under the contract with the Gatineau Power Company. Starting with 6,000 h.p the contract provides for annual increments of 6,000 h.p. up to a maximum of 60,000 h.p. This power is delivered to the Commission at 110,000 volts.

The Ottawa Hydro had two distribution stations, one located at Laurier Avenue and the second at Bronson and Carling Avenues. The power taken under the Ottawa and Hull contract, is brought to these stations by 11,000 volt underground mains. A third station has now been built at the west end of Carling Avenue, connected with the station at Bronson and Carling Avenues by 11,000 volt overhead line carried on steel towers. It is at this point that the Commission has constructed the Ottawa transformer station, stepping Gatineau power from 110,000 volts to 11,000 volts.

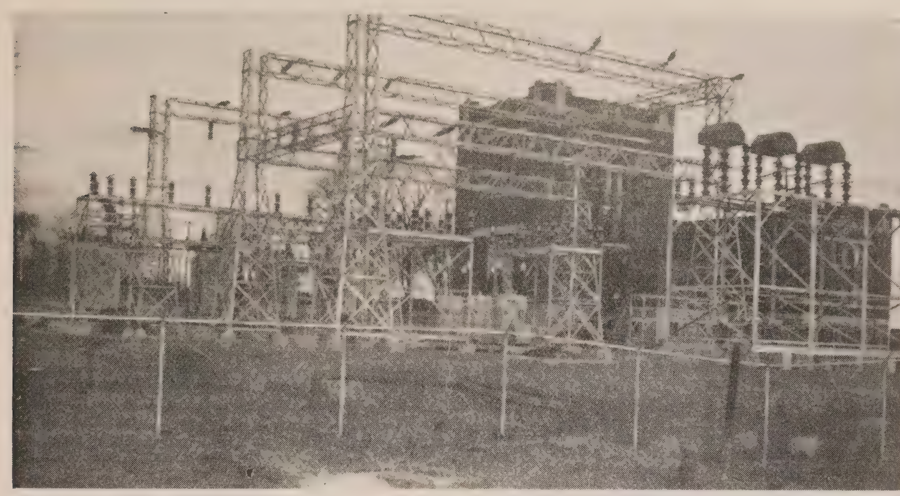
The installation of the 110/11 kv. Ottawa Transformer Station was completed and placed in service on October 28th, 1929. This station is located on the site of the Ottawa Hydro-Electric Commission's Municipal Station No. 3 on Carling Avenue at the west limit of Ottawa. It is served by a short line which connects to the 110 kv. 60 cycle line to Smith's Falls at a point approximately half a mile west of the station.

All of the equipment comprising this station is installed outdoors, except the oil handling facilities, the battery and the switchboard which are installed in the No. 3 Municipal Station. The high and low voltage bus structures are of galvanized steel. All footings and equipment foundations are of concrete.

The initial installation consists of one 110 kv. incoming line feeder, one transformer bank and one 11 kv. feeder connected to the bus of the No. 3 Municipal Station. The station is designed so that it may be extended to provide for two incoming 110 kv. lines and four transformer banks.

110 kv. Equipment

The 110 kv. incoming line is controlled by a Type "G2A" oil circuit breaker manufactured by the Canadian Westinghouse Company. Gang operated swivel type disconnecting switches are installed on each side of the oil breaker. Lightning protection is provided by a 121 kv., Type "O.F." Oxide Film arrester manufactured by

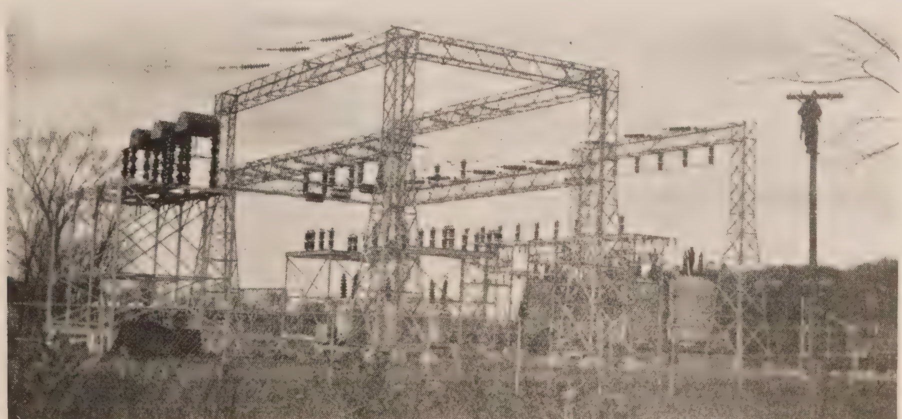


General View of Ottawa Transformer Station looking east

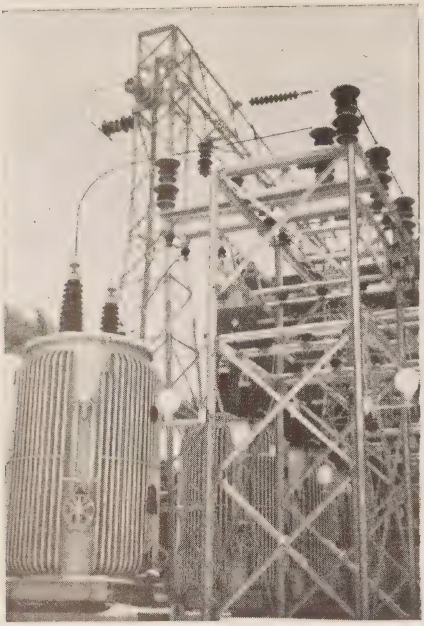
the Canadian General Electric Company.

TRANSFORMERS

The transformer bank is composed of three self-cooled units each rated at 3000 kv-a., 63,500/11,000 volts and manufactured by the Canadian General Electric Company. Their high voltage windings are equipped with three 5 per cent. taps, two above and one below rated voltage. These taps may be changed when the bank is de-energized, by means of an external mechanism mounted on the side of each tank within reach from the ground. External tubes around the tanks provide the radiating surface. Each unit is equipped with a conservator tank. A spare transformer is installed and connection are provided



General View looking north



North end of 11 kv. bus Structure showing spare transformer

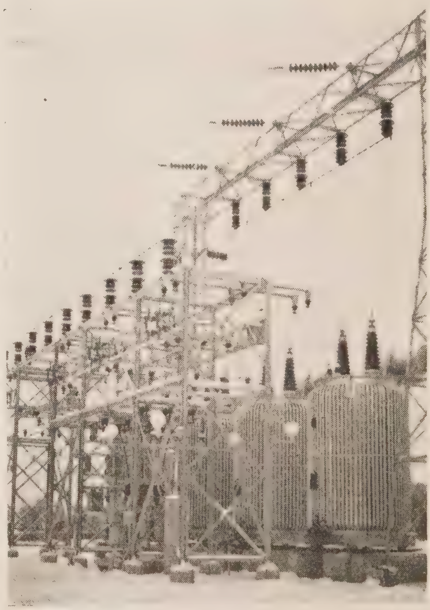
by which it can quickly be connected in place of any unit in the bank.

11 kv. Equipment

The single outgoing feeder is connected to one of the two 11 kv. busses in the No. 3 Municipal Station through three single conductor, 1,000,000 cir. mils, 13,200 volt, paper insulated, lead covered cables and is controlled by a type "CH-1" oil circuit breaker manufactured by the Canadian Westinghouse Company. Disconnecting switches are installed on each side of this oil breaker and also in the leads connecting the low voltage bushings of the transformer to the delta bus. Oil insulated current and potential transformers for metering are mounted on the delta bus structure. All power and control cables are run in underground ducts made up of fibre conduit encased in concrete.

Protective Equipment

The transformer bank and 11 kv. delta bus are protected by relays differentially connected to bushing type current transformers in the 110 kv. and 11 kv. oil breakers. Thus all equipment and connections between these breakers is within the zone of differential protection. High voltage ground protection is provided from the residual current of a second set of bushing type current transformers on the line side of the 110 kv. oil breaker. Low voltage protection is obtained by current-potential balance distance relays connected to current transformers located in the low voltage transformer leads to the delta bus. These relays are set higher



South end of transformer bank and 11 kv. delta bus structure

than those on the Ottawa Hydro-Electric Commission's feeders and act as "Back-up" protection for the latter. All relays were manufactured by the Cansfield Electrical Works Limited.

AUXILIARY EQUIPMENT

A 60 cell Hart battery with Kuprox charger provides the source of direct current for operating the oil breakers. The oil handling equipment comprises a 20 plate blotting paper type filter press, Herringbone gear pump coupled to a 5 h.p. squirrel cage induction motor and two oil tanks each having a capacity of 2560 imperial gallons.

During the construction of this station and the distributing station of the Ottawa Hydro, a temporary supply of power, in excess of 20,000 h.p., was taken from the Ottawa and Hull Power Company's plant. This generating station was taken over, about that time, and operated by the Gatineau Power Company.

The Ottawa Hydro-Electric System has from its commencement, been under the efficient management of Mr. J. E. Brown and with his co-operation the Commission has constructed the 110 kv. station on the same site and jointly with his third station above referred to.

Low Voltage Alternating Current Network System of Distribution

By C. E. Schwenger, Engineer of Distribution, Toronto Hydro-Electric System

THE low voltage a.c. network system of distribution using automatic switches has made great progress during the past few years. Systems of this type are in operation in over thirty cities of the United States and as many others under construction.

Before touching networks, let us first consider the system of A.C. Distribution now in use. In connection with these systems, let us consider only heavily loaded areas such as the Toronto down-town district serving the larger buildings. This district at present is served by 2400 volt and 4100 volt primary feeders underground supplying energy to transformers in vaults located under the sidewalks. This is shown on plan 1. It will be noticed that these vaults are located at important corners such as King and Yonge, Bay and King, Yonge and Adelaide, Yonge and Richmond, etc. Each transformer vault has a capacity of 600 kv-a. and supplies low voltage secondary, 3 wire, 115-230 volt, single phase feeders running radially in all directions. These radial secondary feeders do not tie in with corresponding feeders from other vaults. The reason for this is that these low voltage feeders (plan 2) are on different phases of the three phase system and in very few cases could be tied together. In addition to this difficulty it will be seen that adjacent transformer vaults are

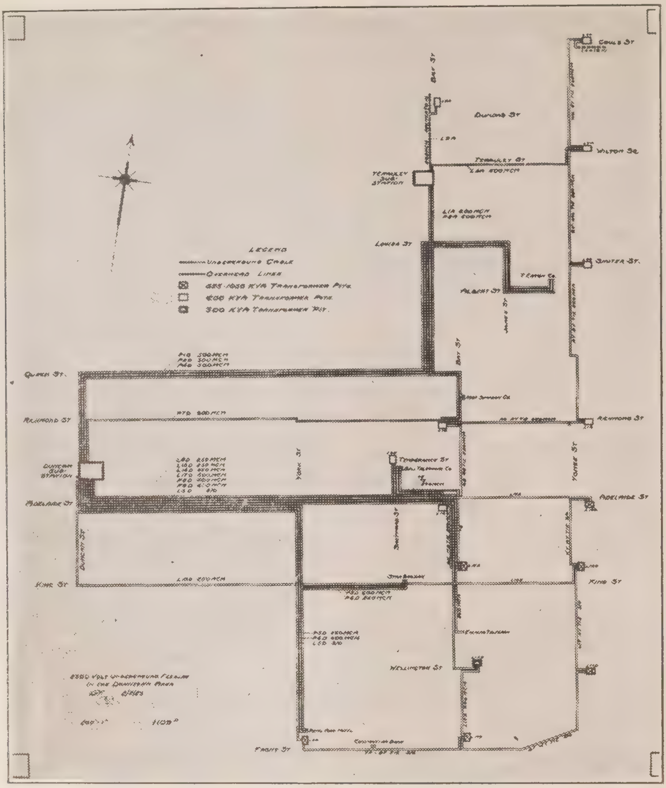


Fig. 1.—Primary Feeder Layout—Existing System

supplied by different primary feeders. Each primary feeder is separately regulated and due to differences in loading and length of such primary feeders the voltage at adjacent transformers is rarely the same. There is nearly always a difference in voltage between transformers and this is another reason why the secondary feeders are not connected together to form a network.

This system lacks very little in economy of capital costs. It will be seen that each vault is supplied with at least two primary sources of supply. There are three separate transformers in each vault connected to each of the phases. The secondary single phase feeders may be quickly switched for supply from any one of the three transformers (Fig.3). In case of trouble, therefore, with this arrangement, we may accomplish much. Should a primary cable break down, the vault may be switched over to the emergency supply. Should a transformer fail, it will blow its fuse, causing an interruption to the low voltage feeders connected to it. These can be reconnected to the remaining active transformers and thus maintain service. In each case there is an interruption to service which holds until the troubleman can reach the vault

in trouble and carry out the necessary switching to restore service. The duration of such interruption will depend upon the speed with which a trouble-man can reach the vault, but will rarely be less than fifteen minutes after the call has been received and nearly always longer.

The switching described above may be carried out automatically as far as the 2400 volt feeders are concerned, but nevertheless, there will be a short interruption, perhaps only a few seconds, but sufficient to disturb the service. It is not so easy to switch the low voltage feeders automatically and this is rarely done.

There is one case of trouble which might occur in any one of these vaults and that is the loss of two or all transformers. No system of switching will restore service. There is, under this condition, insufficient transformer capacity to supply the load and there is no other source of low voltage supply to draw upon. Such a failure would be serious and would involve an interruption which would prevail until other transformers could be installed, a matter of many hours.

Let us consider, for comparison, the direct current network, or what is commonly known as the "Edison System of Distribution" (Fig. 4). This is particularly outstanding in its ability to maintain service. From the sketch, Fig.5, it will be seen that this system consists of a network of mains tied together through fuses at junction boxes. These junction boxes are fed by feeders from d.c. generating stations (see Fig.5). Here it is seen

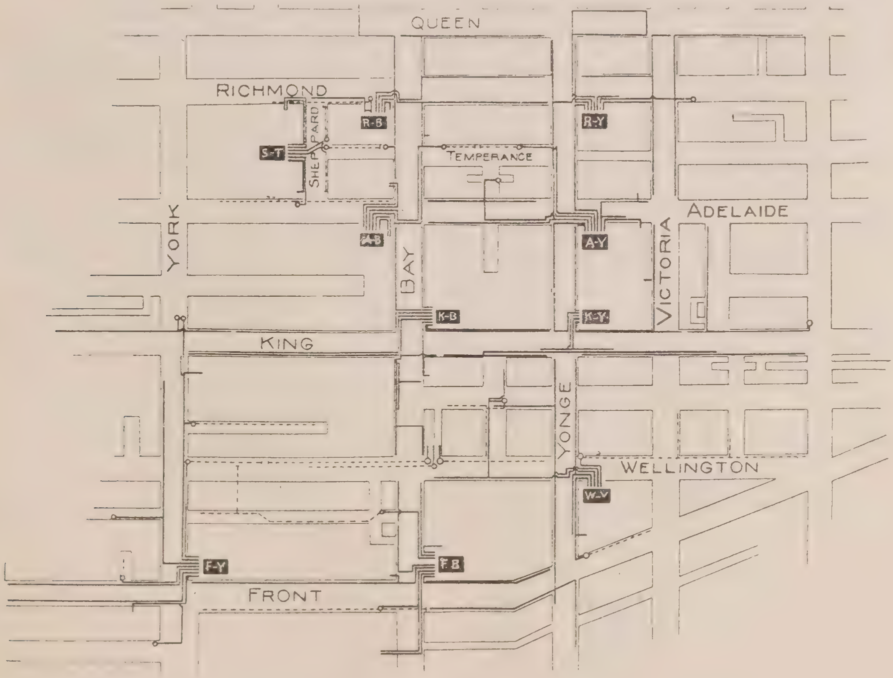


Fig. 2.—Secondary Feeder Layout—Existing System

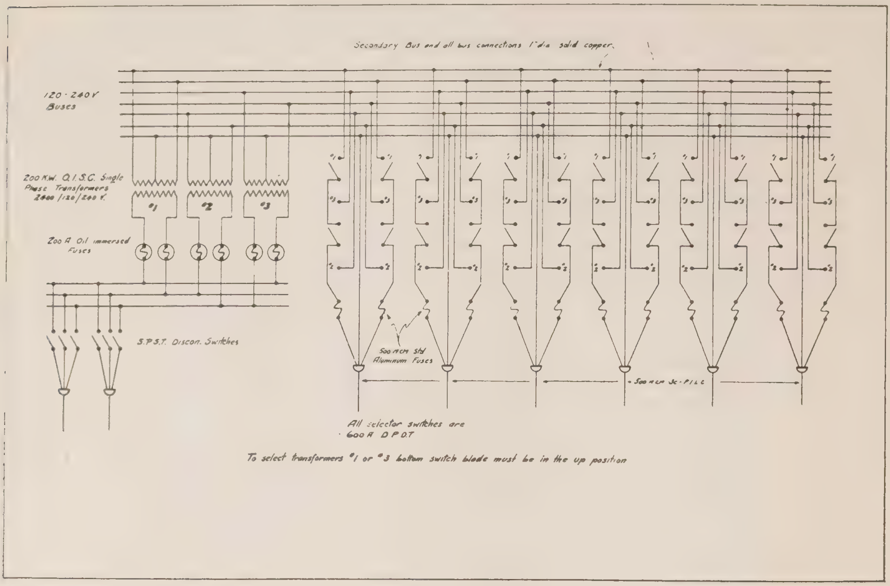


Fig. 3.—Switching Diagram—Existing Radial System

that failure of a feeder from any of the supply stations does not interfere with the continuity of service in the network. Circuit breakers or fuses are installed on each feeder at the station and also at junction box end. These open, thus isolating the defective feeder, and service is then maintained in the network by the remaining feeders. A short circuit on any of the mains between junction boxes either burns itself clear or opens the fuses in the junction boxes at each end of the main, thus isolating the trouble without affecting the rest of the network. For continuity of service this system stands above any radial a.c. system, and in many locations continuity of service may be further insured against failure of power supply by means of large standby storage batteries. This is the system as used in Toronto. The d.c. supply, however, has the very large handicap of higher cost to the consumer due to very expensive generating charges and to the heavy capital carrying charges of its large feeder system. The direct current network, however, supplies both lighting and power from the same mains.

During late years, an effort has been made to accomplish in a network using alternating current similar results to those obtained with the Edison direct current system, the network being throughly tied together and supplied by transformer stations located at points in the network corresponding to the feeder ends on the Edison network. Marked success has resulted from these efforts; in fact, nearly all Edison direct current systems throughout the Continent are now being superseded by some form of low voltage a.c. network which supplies both lighting and power loads.

There are several systems of low

voltage networks at the present time, all of which duplicate the performance of the direct current network, namely, the automatic cutting clear from the network of defective feeders and transformers without affecting the continuity of supply on the rest of the network.

There are two general systems of low voltage networks supplying both lighting and power, the most generally used being three phase, four wire, 120-208 volt. In this case the lighting is 120 volts and the power 208 volts, 3 phase. The other system is two phase, five wire, 115/230 volts, the lighting being 115 volts and the power two phase, 230 volts. In this case both supplies are at what would be standard voltages, namely, 115 and 230 volts.

The 3 phase, four wire system is by far the most generally used and no new systems are being installed except on this system. The power voltage, namely, 208, falls short of the

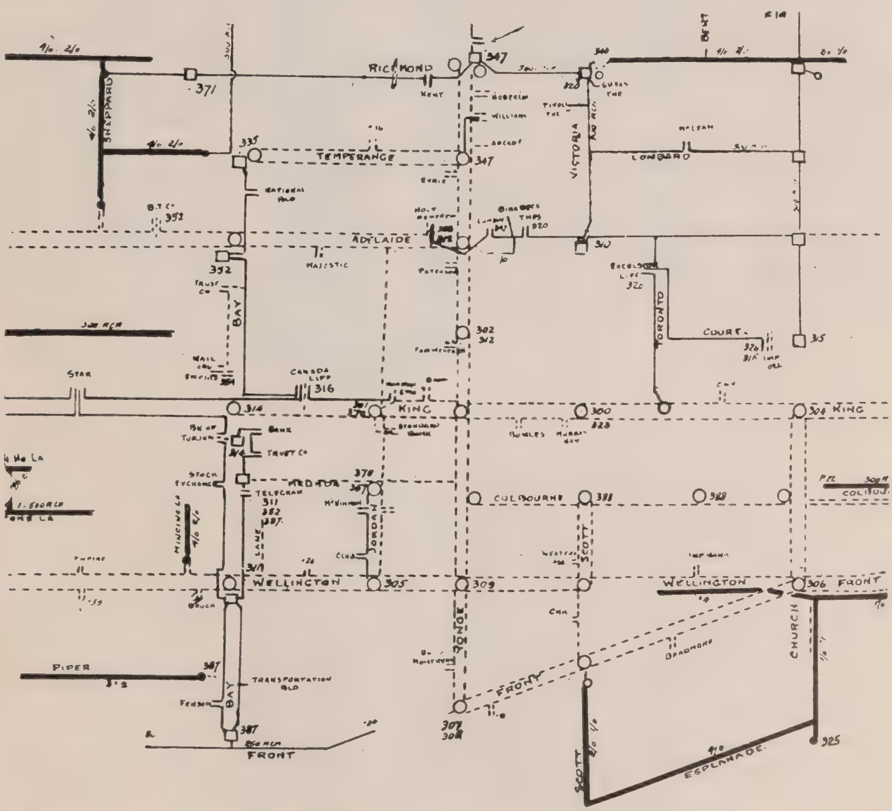


Fig. 4—Edison Mains—Showing Location of Fused Junction Boxes. (Portion of System Only).

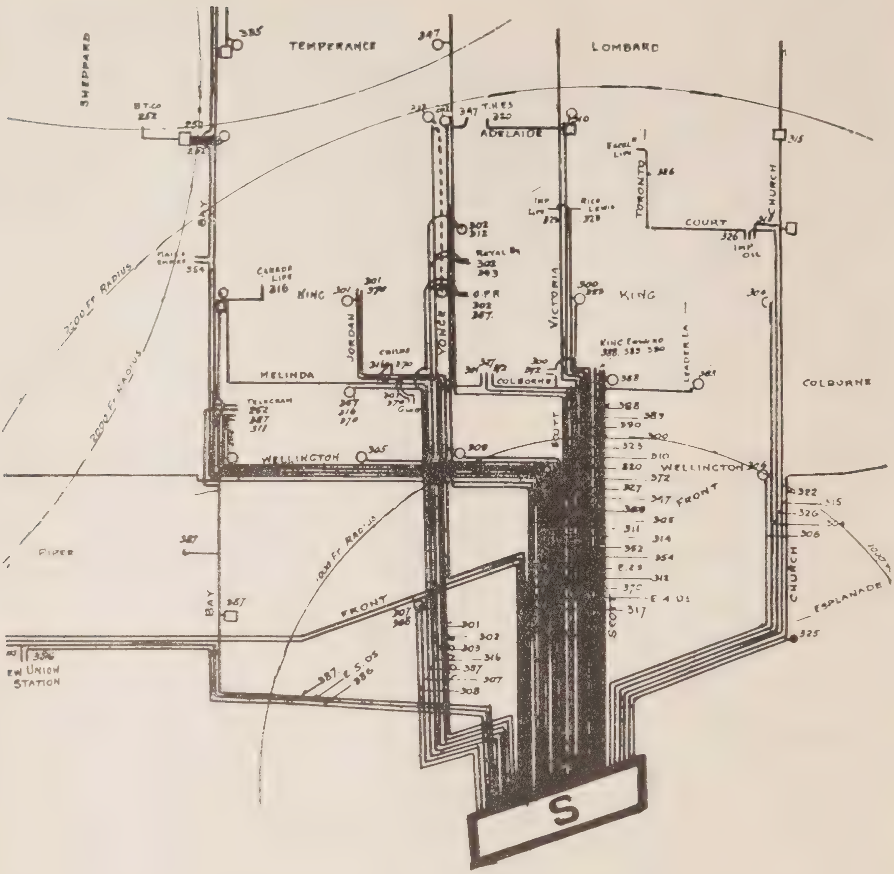


Fig. 5. —Feeders—Edison System. (Portion of System).

standard 220 volts required for motors but it has been found to be quite satisfactory for such use. Sometimes a booster is used to bring the power voltage up to the standard voltage required, but the tendency is to get away from this practice.

Whereas our present radially operated system is supplied at 2300 volts or 4100 volts primary and must stay at this relatively low voltage on account of switching operations required to be made at this voltage, modern low voltage networks are supplied at higher voltages, thus affecting considerable economy. This is probably the outstanding economy possible by use of networks. There is no intermediate substation between the 13,200 volt or generating bus and the network vault. Another economy results when the network is well loaded, at which time the capital cost is less than for the corresponding radial a.c. system.

This scheme depends for its success entirely on the so-called network protector. This device consists of an automatic circuit breaker (Fig.6) capable of handling the full load of the

transformer bank to which it is connected. A protector is connected on the secondary leads of each transformer bank and is designed to open on reversal of power flow. This is accomplished by means of a special reverse power relay. Should a fault develop in a primary feeder cable or transformer connected thereto, the primary feeder switch at the supply station opens. The low voltage network will, however, supply power to it, that is, there will be a reverse flow of power. Immediately this reversal of current takes place, the network protector switch opens and thus disconnects the defective equipment from the network. This action is so fast that no disturbance to network voltage takes place. On resumption of normal conditions on the feeder or transformer in trouble, another relay known as the phasing relay closes the network protector when voltages are nearly equal. Thus we have a means of cutting clear defective feeders automatically and also a means of restoring service automatically after the defect has been repaired.

Another feature which is greatly in favor of such a low voltage network is that primary feeders may be taken out of service at any time and equipment in the manhole or vault may then be worked on dead. When a feeder supplying a network is opened at the supply end, a reversal of power takes place in each protector due to the magnetizing current taken by the transformers. This small reverse current is sufficient to open the protector. When the feeder is again energized the phasing relay immediately closes the protector switch.

It will be seen that we now have duplicated the feeder end of the Direct Current network. We can open any

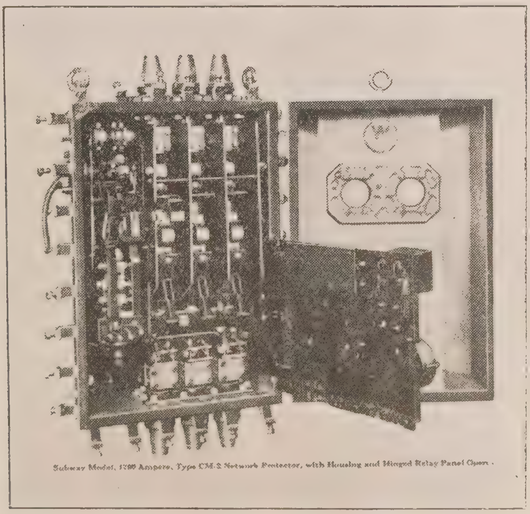


Fig. 6.—Typical Network Protector—Submersible

feeder either by hand or automatically in case of trouble without affecting the voltage supply on the network.

Coming now to the secondary network proper, that is, the tied in feeders on the load side of all the protectors, we have the choice of several arrangements to handle troubles which might develop. Should a short circuit take place on the secondary grid between transformers, there is, when protectors are used, no way of interrupting this short current. The network protector does not open under overload but only opens on reverse power as stated above. With so many transformers supplying energy to the network a very large amount of short circuit current is available. This short circuit is only limited by the impedance of the transformers and primary feeders which is on the order in most systems of 10 per cent., i.e.,with a short circuit at the transformer secondary about 10 times full load current is fed into the short circuit. This short circuit, however, is somewhat lowered by the impedance of the secondary cable and this depends on how far from the transformer the fault is located, also how many transformers are feeding into the fault.

In the direct current network it has been the practice to isolate the main in trouble by allowing fuses to open at each end of this main. It has, however, been found that such troubles do not always blow only the fuses at each end but very often due to inaccurate rating of fuses many other fuses in the network also open. Thus a short circuit on a section of main may cause interruptions to other good mains. Lately on direct current networks the practice has been to omit fuses on the mains and provide sufficient short circuit current as will burn clear any main which might develop a short. This latter practice is also followed in most low voltage a.c. networks and as shown above a large short circuit current is available for this purpose.

It has been found on systems having installed total transformer capacities on order of 5000 kv-a. that secondary mains of 500 cir. mils can be burned off successfully. The minimum amount of short circuit current necessary to clear a 500 cir. mils cable is on the order of 5000 amperes, much more than this is usually available.

The best practice seems to be to provide a very heavy short circuit capacity on the network, heavy enough to burn off any conductors of secondary grid which might come into contact. To be sure of sufficient current it has been found better to make the network solid without the use of sectionalizing fuses. Thus any main developing trouble will be burned off and no other mains will become involved in the trouble.

It has been found that single conductor lead covered cables take less current to burn clear than corresponding three conductor cable. For this reason single conductor cable is almost universally used in low voltage networks. Three core cables from old systems, however, are in use and are giving good service, but are not being used for new extensions.

Customers' services are, of course, always fused as in present practice. These fuses are located on the consumers' premises. No fuses are used where consumer's service cables leave

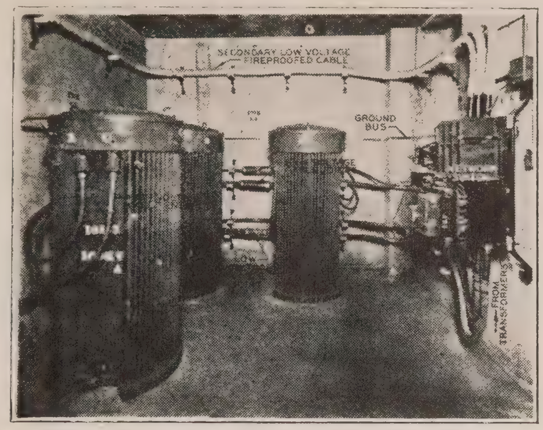


Fig. 7.—Typical Manhole Installation

the street mains; these are tied in solid.

Summary

A network system may be made with entirely submersible equipment, i.e., the transformers would be of subway type capable of complete submersion under water. The network protector may also be of this type and with the lead covered cables both high tension and on the low tension side sweated to these devices, it is impossible for water to enter. Such systems are necessary where extreme flood conditions prevail, but one system which has a great deal of flooding uses submersible transformers only and open type protectors (Fig.7). Apparently these protectors can withstand moisture without causing trouble and can be put back into operating condition by later drying out.

The 3 phase, 4 wire system of distribution makes it necessary to handle consumers' loads differently to the method now in vogue. In order to obtain good balance on all phases of the network, it is desirable to run four wire services to consumers. In regard to balance, one company will not allow more than 30 amperes (3.6 kv-a. unbalance). Thus a one phase or 2 wire service of 30 amperes (3 kv-a.) is allowed or a 7.2 kv-a. which means 3.6 kv-a. on each of two phase wires or 3 wire service is allowed, the unbalance being only 3.6 kv-a. Where loads are greater than, say, 100 kv-a., a vault should be installed adjacent to or in the building so loaded. Some companies allow as high as 25 kv-a. unbalance in the case of 3 wire services.

The metering for 3 wire or 4 wire services is carried out by self-contained 2 element meters or 3 element meters respectively.

Motor starting currents are limiting features of maximum sized motor which may be operated from the 4 wire network. Resistance starters of Allen Bradley type are commonly used. Motors up to 250 h.p. are in use on some systems.

Conclusions

Where load densities are heavy, i.e., on the order of 30,000 kv-a. or higher

per square mile, low voltage a.c. networks are desirable because of—

1. Reliability of service. This was explained above.

2. Elimination of operation costs in substations.

3. Elimination of maintenance costs in substations.

4. Economies of operation due to use of higher voltages of transmission and reduction of distribution losses. During lightly loaded periods, also, a large portion of the feeder system and transformers may be cut out of service thus reducing the losses at such times.

5. Lower cost of serving the district.

6. The network is capable of indefinite expansion within any given area or may be easily extended beyond to include a greater area. The limitations of other existing schemes have already been pointed out.

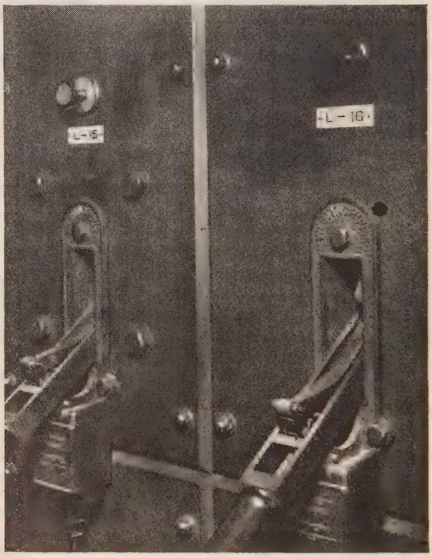
T.H.E.C. Monthly.

Designating Equipment in Sub-Stations

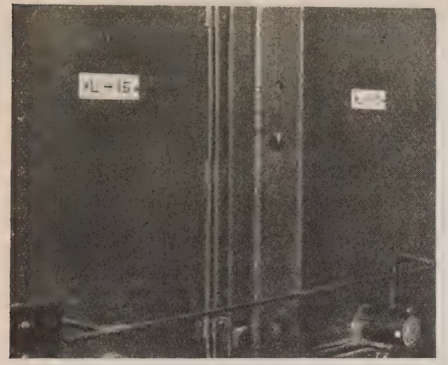
By J. W. Peart, Manager Hydro-Electric Commission of St. Thomas, Ontario

SUB-STATION operators will appreciate that the matter of affixing tags to designate the various feeders, oil circuit breakers, transformers and disconnecting switches which they are required to operate from time to time is one that is given too little attention in many installations. Most switchboard panels come through from the manufacturer with a small brass card holder affixed in the required position, this holder carrying a sheet of mica. It invariably falls to the lot of the chief or the operator himself to exert whatever drafting ability he may possess to place the numerals designating the feeder on a slip of paper, cut it to the required size and slip it into the card holder.

The result of this effort is far from satisfactory. In the first place, the space available is too limited to allow the designation to stand out plainly for easy interpretation. Secondly,



Feeder Markers on front of Switchboard panels.



Feeder Markers on back of Switchboard panels.

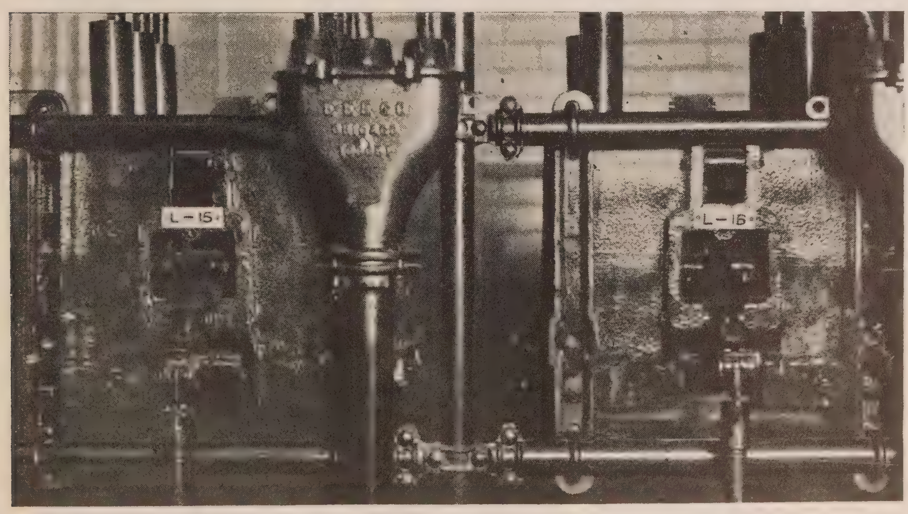
dirt accumulates in these card holders which, together with a minute seepage of oil which occurs frequently, tends to obliterate the marking.

The writer has given this matter some consideration, realizing from years of operating supervision that an operator is liable to make mistakes if his controls and various pieces of equipment are not clearly designated. Mistakes in operation cannot be reconciled, therefore equipment must be clearly designated.

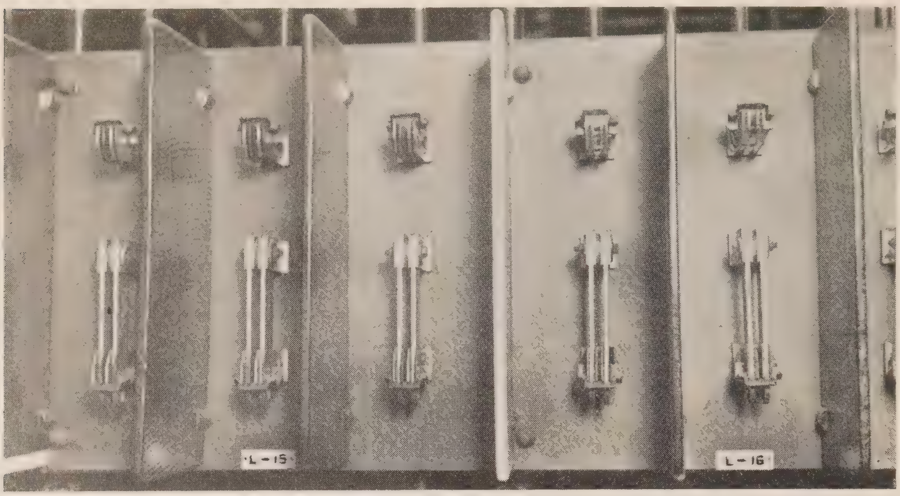
In solving this problem the writer has resorted to the use of enamelled plates, 3 inches x 1 inch, having a white ground with blue numerals or letters. If these plates are obtained with two ⅛-inch. holes just large enough to take small brass screws they can be attached to the switchboard by a simple process of drilling and plugging.

If it is desired to distinguish controls on high tension oil breakers from those on low tension breakers, red numerals or letters may be used in one case and blue in the other. This in itself gives an operator materal assistance in selecting his high tension controls in cases of emergency especially when they are intermingled with low tension controls along a 40 or 50 foot board.

Such plates can be readily obtained from any firm manufacturing enamel



Feeder Markers on low tension breakers



Feeder Markers on disconnecting switches

ware at a cost approximating 15 cents per plate.

In ordering plates it is well to obtain seven or eight of each designation so each feeder may be distinctly marked from the switchboard control to the outdoor cable terminal.

A point often overlooked is that of tagging the rear of switchboard panels as well as the front. In many cases the test links are mounted on separate miniature panels on the back of the main panels and the work of a meter or relay inspector is greatly facilitated when he is able to select his panel without taking the time to count from one end or having a check made by the operator stationed out in front.

Nearly all modern installations of switching equipment provide for remote control of oil breakers. Under such conditions it is desirable to place a tag on both front and back of the breakers as well as on all disconnecting switches.

Tags may also be attached to feeder cables at strategic points by wiring the plates about the cable fireproofing as well as fastening them on the outdoor cable terminals.

A few photographs have been included with this article to give a clear idea of this method of feeder designation. The subject may appear to be of minor importance, yet anyone in the operating field will appreciate its significance and value not only as a means of facilitating operation in general but as an outstanding essential to safe practise.

National Safety News.

And now comes a new system of cooking our victuals. Miss Lenore Sater of the *Household Equipment Staff* of the Iowa State College now recommends electrocuting our steaks, chops, potatoes etc. The device in its present stage, consists of an ordinary glass jar with a steel plate in the bottom forming one electrode. The other electrode is a steel plated plunger which is placed in the jar, and *there you are.* Place your meat, vegetables or whatever you want to cook, in the jar and merely throw the switch.

Thomas Topics.

Practical Use of Vectors in Electrical Work

By H. S. Baker, Meter Engineer, H.E.P.C. of Ont.

THE following is intended rather as a practical talk than an academic development of the subject.

We will consider some actual uses of vector diagrams of alternating electric currents and voltages but will take up currents alone first.

The variations of the instantaneous values of an electric current can be represented or pictured in several ways. The length of a line can be made to vary and represent the variations of a given electric current.

1. Time Graph of a Variable

Let us consider such a variable line HL in Fig. 1. This line is vertical and is moving from left to right with its L end always upon the base line and its H end describing the curve as shown. This curve gives a clear picture of the variations of the length of the line and also of some electrical current represented by the line. The progress of time is represented by the uniform motion of the point L along the base line from left to right. Each point on the base line and vertical line through that point represents an instant of time.

This figure is a "time diagram" showing the variations of the instantaneous values of current as time progresses.

2. Time and Space Co-ordinated

The current which is represented by HL Fig. 1 is actually flowing in conductor R Fig. 2. This Fig. 2 is a space diagram showing where it is that the current flows. The time

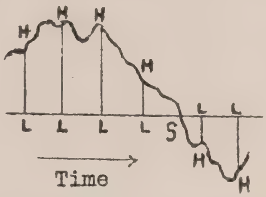


FIG. 1
Graphic Time Diagram

diagram tells us when and how much and the space diagram tells us where.

3. Arbitrary Positive Direction

We have chosen to designate the direction shown by the arrow Fig. 2 as the arbitrary positive direction along the conductor. At the instant represented by S Fig. 1, the current in Fig. 2 is zero. After this time the length of HL Fig. 1 has become negative and the actual current in Fig. 2 is flowing negatively or against the arbitrary arrow.

Here we see that a time diagram such as Fig. 1 must be coupled with a space diagram such as Fig. 2 in order to properly express the time variations of space happenings.

Arrows are sometimes used in space diagrams to indicate actual direction of flow at a given instant of time, but unless otherwise specified we will use the ampere arrows on space diagrams

FIG. 2
SPACE DIAGRAM
Showing positive
direction along
conductor

to represent arbitrary positive direction along the conductor. We may choose either direction as positive so long as we keep our time diagram consistent with the chosen positive direction.

4. Wave Form and Cycle

If the current Fig. 2 be an alternating current then the time curve will take the form of waves as shown Fig. 3 and the shape of this wave is called the wave form of the current flowing in Fig. 2. The current in Fig. 2 if applied to an oscillograph will cause it to draw the curve shown in Fig. 3. If this current be applied to an ordinary a.c. ammeter it will show a deflection which is about 71 per cent. of the crest value of the wave shown in Fig. 3.

One complete cycle of changes as represented from S to F, Fig. 3 is called one cycle and for 25 cycle current, this cycle occupies 1/25 of one second.

A certain smooth form of wave is called "sinusoidal" and we will consider only these in the crank vector diagrams given below, because crank vector diagrams represent only sinusoidal variations. The meaning of sinusoidal variation will be explained later.

5. Two Vector Systems

There are two systems of vector diagrams: — one is "Crank Vectors" and the other is "Polar Vectors".

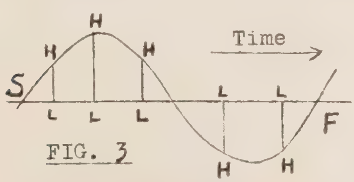


FIG. 3
Alternating Current
Graphic Time Diagram.

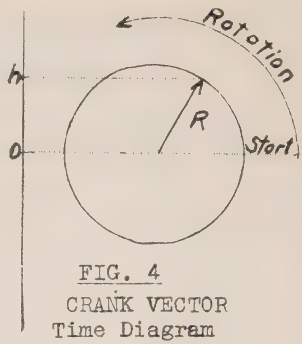


FIG. 4
CRANK VECTOR
Time Diagram

Polar Vectors will not be considered here except as a brief note at the end, intended to avoid confusion caused by the common term "Vector Diagrams" being applied to both systems.

6. Sinusoidal Variation

Sinusoidal variation may be simply pictured as follows: — A crank R Fig. 4 turns uniformly to the left making one revolution in one cycle of time. The vertical projection of the crank (which is the line h o) increases in value to a maximum and shrinks to zero and becomes negative in length and so on. The variation of the length of the vertical projection of the crank R is called "sinusoidal variation". The instantaneous values of current in a sinusoidal alternating current undergo this same kind of variation, hence this vertical projection is used in the crank diagram to represent the varying instantaneous values of the current, in the same way that the line HL Fig. 3 represents it.

7. Electrical Degrees

Any position of the vector R represents an instant of time and fixes the value and sign of its vertical projection (h o) for that instant. The angular position or direction of the vector R represents the amount of time elapsed from the instant when

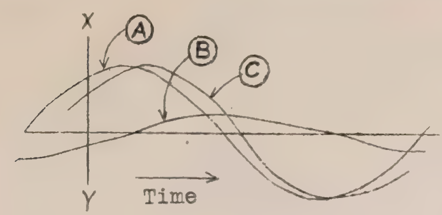


FIG. 5
Time Diagram
Addition of Curves

it was in a horizontal position with its point to the right at the beginning of the cycle.

The amount of time taken for the vector to rotate one revolution is called one cycle or 360 electrical degrees of time.

In Fig. 4 the vector R constitutes the whole vector diagram. Later we will see a diagram made up of several vectors forming a figure which will be considered to rotate bodily around to the left, and each position of the figure will represent an instant of time, and the vertical projections of the various vectors will represent all the instantaneous currents at that time.

8. Time Vector and Space Co-ordinated

If we now consider Fig. 4 and Fig. 2 together as time and space diagrams and let h o, Fig. 4, represent instantaneous current flow in Fig. 2 we have a representation of sinusoidal alternating current in the conductor Fig. 2. Fig. 4 is a crank vector time diagram and Fig. 2 is its allied space diagram or wiring diagram.

The variations of (h−0), Fig. 4, are the same as the variations of HL Fig. 3, and the length of the crank R is the maximum length of (h−0), which is the crest value of the alternating current represented.

9. Addition of Two Vectors

Let us now consider the addition of two alternating currents in one conductor. Fig. 5 and Fig. 6 will be the pair of time and space diagrams used. Let the curve A Fig. 5 and let the Curve B Fig. 5 similarly represent currents in A and B Fig. 6. Now at every instant of time the instantaneous current in conductor C Fig. 6 is the algebraic sum of the currents in A and B Fig. 6.

In Fig. 5 we have added the ordinates of the curves A and B together algebraically to get the curve C Fig.5. This summation curve C Fig. 5 will then represent the variations in instantaneous values of the summation current in Conductor C Fig. 6. It will be noted that the amplitude or crest value of Curve C Fig. 5 is not the sum of the amplitudes of the curves A and B Fig. 5 in spite of the fact that A and B curves were added together to make C. This is because the crests of A and B do not occur at the same instant.

Thus an ordinary a.c. ammeter in conductor C Fig. 6 would not read the arithmetic sum of the ammeter readings of A and B. The ordinary a.c. ammeter reads about 71 per cent. of the crest value which is called the r.m.s. value.

While the diagram Fig. 7 is shown in a fixed position it is of course considered to be rotating to the left. The

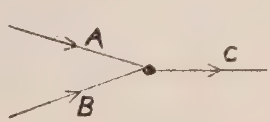


FIG. 6
Space Diagram
Addition of Currents

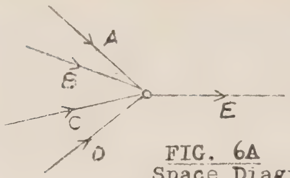


FIG. 6A
Space Diagram
Addition of Currents

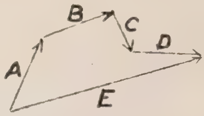


FIG. 7A
Time Diagram
Addition of
Current Vectors

position shown corresponds to the same instant of time that is represented by the line XY Fig. 5.

Here the vertical projection of A Fig. 7 is (h_1-0). This is the instantaneous current in A Fig. 6 for that position of Fig. 7 and for the instant XY Fig. 5.

The projection of the vector B is (h_2-h_1) and the algebraic sum of (h_1-0) and (h_2-h_1) is of course (h_2-0). This (h_2-0) is seen to be the projection of the vector C Fig. 7. This vector C then has always for its projection the quantity (h_2-0) which is the instantaneous summation current in Fig. 6, therefore the summation vector C is the vector of that summation current.

We can now note that the vector C is derived from the vectors A & B by placing A & B tail to point and connecting the free tail to the free point by a line which is the vector C. The tail and point of C are the free tail and free point of the A & B combination.

The rule then for the addition of

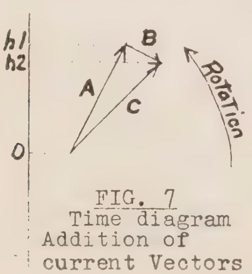


FIG. 7
Time diagram
Addition of
current Vectors

two vectors to get a single summation vector which will represent the sum of the quantities represented by the 2 vectors, is to place the two component vectors tail to point and take the free tail and the free point as the tail and point of the summation vector. The same rule applies to several vectors.

10. Addition of Many Vectors

Consider now:— Figs. 7A and 6A. The vectors A,B,C and D in Fig. 7A add vectorially together to make the vector E Fig. 7A. This is the vector of the summation current in conductor E Fig. 6A. Thus to get the summation of a number of vectors all of which are of known length and direction, place all the component vectors tail to point and take the free tail and free point for the tail and point of the summation vector. The order in which the component vectors are taken makes no difference to the result. In following the above rule bear in mind that the arrows in the space diagram are as per Fig. 6 or Fig. 6A where all the component arrows are towards the totalizing junction of the conductors and the arrow on the totalizing conductor is away from the junction.

11. Vector Equations

The equation of instantaneous values for Fig. 7 is written (h_1-0) plus (h_2-h_1) equals (h_2-0). The vector equation for Fig. 6 is written:

$\overline{A}+\overline{B}=\overline{C}$ meaning that vectors A

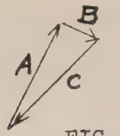


FIG. 9
Addition of 3
Vectors to zero
C is reversed

and B together have the same tail and point as C.

The Vector equation for Fig. 7A is written

$\bar{A}+\bar{B}+\bar{C}+\bar{D}=\bar{E}$

The above two vector equations may be written in a symmetrical manner and still represent properly the same physical facts as before. If we reverse the arbitrary positive direction in conductor C Fig. 6 and at the same time reverse the direction of the arrow on Vector C in 7 we will have the pair of time and space diagrams Figs. 9 and 10. The Vector equation will now be written

$\bar{A}+\bar{B}=-\bar{C}$ or $\bar{A}+\bar{B}+\bar{C}=0$

These three vectors Fig. 9 placed tail to point form a closed triangle and the vector sum of the three is zero. Hence in Fig. 10 the vector sum of the three currents in the three conductors A B and C (with positive arrows all pointing towards the star point) is zero.

The same thing applies to Fig. 6A and 7A with the E arrows reversed. We then have $\bar{A}+\bar{B}+\bar{C}+\bar{D}+\bar{E}=0$. The vectors all connected tail to point form a closed figure, or have a total of zero.

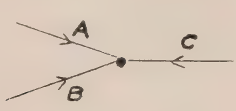


FIG. 10
Space diagram
Addition of 3
Currents to zero
Arrow C is reversed

12. TIME LAG

In Fig. 5 the curve B crosses the base line upwards one quarter of a cycle later than the curve A crosses it in the same way hence the alternating current in B Fig. 6 is said to lag the alternating current in A by 90 electrical degrees or one quarter of a cycle.

As Fig. 7 rotates to the left the direction of the Vector B becomes horizontal towards the right at 90 degrees of time later than the direction of the Vector A does, hence B is said to lag A by 90 degrees as stated above. Both Fig. 5 and Fig. 7 show the summation current C to lag slightly behind the A current.

13. CREST VALUE

Any vector when vertical has a projection of the same length as itself hence the length of the vector represents the crest value or maximum value of the instantaneous current represented by it. This crest value is 1.41 times the a.c. ammeter reading which ammeter reads the r.m.s. value.

14. SPECIFIC EXAMPLE-ADDITION OF VECTORS

Let us now work out a concrete example taking the facts similar to those expressed in a general way in Figs. 6 and 7 and assign actual values to make everything clear as to its exact meaning.

We will take Fig. 6 for our space diagram or wiring diagram and develop Fig. 11 for the time diagram. Fig. 11 will be Fig. 7 worked out to scale and expressing definitive quantitative data and results. The known facts are taken as follows:—

1. The a.c. ammeter reading (or

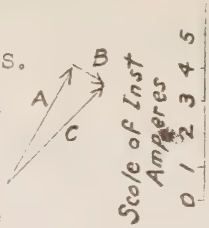


FIG. 11
Specific Case
using inst. amp. scale.

the r.m.s. value) of the current in conductor A is 4 amperes.

2. The r.m.s. current in B is 1 ampere and lags the current A by 90 degrees.

The problem is to work out graphically by vectors the r.m.s. value of the current in conductor C and also determine how much it leads or lags current A.

In this case we still assign a scale of instantaneous amperes and stick to it throughout this diagram Fig. 11. The scale will be 1/4 inch equals one instantaneous ampere. (In later diagrams we will find it simpler to assign a scale of r.m.s. amperes which will be explained).

In Fig. 11 we have first laid off the ampere scale, noted above as one instantaneous ampere per 1/4 inch. The crest value of 4 r.m.s. amperes is 4x1.41 or 5.65 amperes. The crest value for one r.m.s. ampere is 1.41 amperes. These values are the vector lengths when plotting to a scale of instantaneous values. We then lay off the vector A in any direction and make it 5.65 instantaneous amperes long. Next start from the point of vector A and lay off vector B in a direction lagging A by 90 degrees and make B 1.41 amperes long. The vector C which joins the tail of A to the point of B is found to measure 5.85 instantaneous amperes long, or C has an r.m.s. value of 4.12 amperes.

The angle that the vector C lags behind the vector A can be scaled off the diagram and found to be 14 degrees. That is, the current in conductor C Fig. 6 lags behind the current in conductor A Fig. 6. by 14 electrical degrees or 14/360 of one cycle of time or 14/360 of 1/25 of a second of time.

15 Scale of r.m.s. Values (Fig. 12)

Let us now repeat the above problem, but for convenience we will make the length of the vectors equal to the r.m.s. amperes represented. We lay off our scale say one r.m.s. ampere equals 1/4 inch. A is now 4 amperes long and B is one ampere long, and we can measure C which will be found to be 4.12 amperes long, r.m.s. value as before. The same procedure applies to the addition of many current vectors to get the value of the composite current, as in Fig. 7A and 6A.

16. Routine of Current Vector Plotting

We can now summarize the routine of the method outlined above for dealing with currents and current vectors.

Let each current on the space diagram and each current vector in the time diagram be named by the same capital letter.

Assign a scale of r.m.s. amperes per inch.

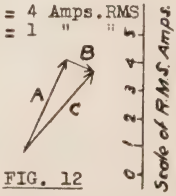


FIG. 12
Specific Case
Using R.M.S. Amp. Scale

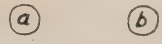


FIG. 13
Voltage Difference
Space Diagram

FIG. 15
Voltage difference
Space Diagram

Place arbitrary positive direction current arrows on the conductors of the space diagram.

Lay off the vectors in accordance with the given data expressed, in keeping with the positive directions assigned to the conductors.

17. Voltage Difference Vectors

Let us now consider the fundamentals of representing alternating voltages and establish a suitable routine for plotting them.

Any voltage is a voltage difference and is the difference in potential between two given points. We may picture the potential of one point as its absolute pressure. Another point has a different absolute pressure either higher or lower than the first. The potential of point a, Fig. 13 may be represented by some height ha Fig. 14 and the potential of b, Fig. 13 by hb Fig. 14. The instantaneous voltage difference between the two points is then represented by the difference of levels or by the line (ha—hb).

If this voltage difference undergoes a sinusoidal variation, (or is an ordinary alternating voltage) then the variations in voltage may be pictured as the vertical projection (ha—hb) of the rotating voltage vector (a—b) Fig. 14.

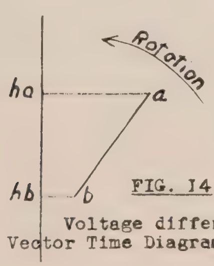


FIG. 14
Voltage difference
Vector Time Diagram

During the intervals of time when a is higher up than b in the time diagram Fig. 14 then the instantaneous absolute potential of "a" in the space diagram Fig. 13 is greater or more plus than the absolute potential of "b".

During these intervals (ha—hb) is positive. An ohmic resistance between a and b Fig. 13 would then carry current from a towards b.

We will not use arrows on either the voltage time diagram Fig. 14 or the voltage space diagram Fig. 13. The use of arrows is best reserved for currents, and is seldom necessary in picturing voltage differences.

There is no choice between two points as to which to name first in the "difference expression" (a—b) so long as we keep the time and space diagrams consistent.

18. Examples

In regard to the above pair of diagrams we will say that the vector (a—b) Fig. 14 represents the voltage difference (a—b) Fig. 13. We might as well have said that (b—a) Fig. 14 represents (b—a) Fig. 13.

Consider now three points a, b, and c Fig. 15 and three vectors (a—b), (b—c) and (c—a) Fig. 16.

It is evident that at an instant of time the instantaneous pressure differences (a—b), (b—c) and (c—a) in the space diagram add up algebraically to make zero. These differences we pictured in the time diagram as (ha—hb), (hb—hc) and (hc—ha)

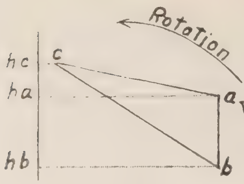


FIG. 16
Voltage Difference
Vector Time Diagram

which obviously add up algebraically to zero. These last three differences are seen to be the vertical projections of the three corresponding time vectors (a−b), (b−c) and (c−a) in the time diagram Fig. 16.

We will then say a, b, c, Fig. 16 is the voltage vector diagram of the voltage differences of the points a, b, c, Fig. 15.

If Fig. 16 is plotted to a scale of r.m.s. voltages, and if we place three r.m.s. voltmeters in (a−b), (b−c) and (c−a) Fig. 15 then the three voltmeter readings will be measured by the lengths of the three sides of the triangle in Fig. 16 when measured to the r.m.s. voltage scale to which Fig16 was plotted.

19. Voltage Phase Diagnosis

If we are given three terminals such as a, b, c, Fig. 15 and a voltmeter we can measure the three voltage differences and plot them to scale to form a triangle. The angle between the vectors then will be the amounts of time lag between the corresponding voltages. This diagram thus plotted may however, have the wrong rotation. That is to say, the vectors which lag others may represent voltages that lead. A simple means of getting the correct rotation will be taken up later.

20. Voltage Diagram Plotted From Given Data

Another specific case would be as follows:—

Given that voltage (a−b) Fig. 15 lags the voltage (c−b) by 36.8 degrees of time and that (a−b) is 50 r.m.s. volts and (c−b) is 110 r.m.s. volts we may lay off (a−b) and (c−b) in Fig. 16 to this angle and these values. We will then find on measuring the vector (c−a) that it has a value of 76 volts and leads the voltage (a−b) 60 degrees.

21. Routine of Voltage Vector Plotting

To summarize the routine for voltage vectors, place small letters at the points to be considered on the space diagram.

Decide on a suitable scale of r.m.s. volts per inch. Plot the known voltages in their known direction and values.

Let the voltage points in the space diagram and the corresponding ends of voltage vectors be marked by the same small letters.

Scale off the unknown voltages from the vector diagram thus plotted.

This we have done in the example cited above.

22. Importance of Practice in Specific Applications

We will now take up a number of specific uses of vectors and try to show that it is worth while to know vectors as we know our arithmetic. The language of vectors is indulged in by many who do not know their vectors in antyhing like the practical manner that they know their arithmetic and there is need for more study of practical applications along this line.

We will then plot some vector diagrams in a general way to illustrate general principles, and will also plot some to scale to get concrete results.

The ordinary indicating a.c. wattmeter is the most useful tool we can use in practical investigations of phase relations in a given operating network, and we will take it up first.

The correctness or errors in meter wiring and relay wiring networks can generally be determined by a phase diagnosis of the currents and voltages being delivered to the meters or relays.

23. Definition of A. C. Watts

Let us first describe exactly what a.c. watts are, and then see how it is that the moving coil Wattmeter measures these watts.

The quantity "A.C. Watts" is the average over a whole cycle of the instantaneous values of wattage. The instantaneous wattage is the product of the instantaneous amperes and instantaneous volts. Then the a.c. wattage in a single phase circuit is the average of the varying product of instantaneous amperes and instantaneous volts.

24. Moving Coil Wattmeter Torque

Now the instantaneous torque in the wattmeter is produced by the instantaneous reaction of the current in the fixed coil upon the instantaneous current in the moving coil. This torque is proportional to the product of those two currents, but the current in the moving coil is in turn proportional to the instantaneous volts, and the current in the fixed coil is the instantaneous amperes hence the instantaneous torque (which is produced directly by the product of instantaneous coil currents) is indirectly produced by the product of instantaneous volts and instantaneous amperes which product is the instantaneous watts.

The average torque is then produced by the average watts. This torque winds up the meter spring till the pointer indicates the value of the a.c. watts.

In the above it was shown that the relation of wattmeter torque to a.c. watts was fixed without specifying any relationship between thevariation of amperes to the variation of volts hence the moving coil wattmeter measures watts regardless of phase relations of amperes, to volts or of wave form, or of frequency.

25. r.m.s. Value

At this point we should understand what is meant by the r.m.s.value, which is about 71 per cent. of the crest value and why the r.m.s. value is generally used. The letters r.m.s. stand for "Root of the mean of the squares of the instantaneous values". The square of any instantaneous value is positive whether the instantaneous value is positive or negative, hence the mean of the squares is always positive. The plain average of the instantaneous values is of course, zero over a whole cycle.

If "a" is a variable representing the instantaneous values then $\sqrt{\text{mean of } a^2}$ is the root of the mean of "a" squared, or the r.m.s. value of the variable a. If "a" undergoes a sinusoidal variation it can be shown that the r.m.s. value is 70.7 per cent of the crest value of "a".

26. r.m.s. Amperes and Volts, and Average Watts

Consider a current and a voltage which are in step, and we will work out first the product of the r.m.s. values, and then work out the average watts, and we will find them to be the same value.

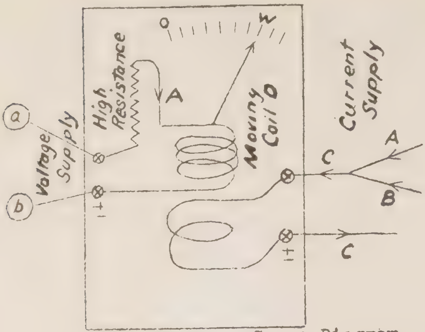


FIG. 17 Space Diagram Moving Coil Wattmeter

Call the varying instantaneous current i and the varying instantaneous voltage e. Since the current and voltage are in step, they rise and fall together, then i is proportional to e and we may say $i = ke$ where k is constant.

The r.m.s. of e is $\sqrt{\text{mean of } e^2}$

The r.m.s. of i is $\sqrt{\text{mean of } i^2}$ or is $\sqrt{\text{mean of } (ke)^2}$ or is $k\sqrt{\text{mean of } e^2}$ The product of $\sqrt{\text{mean of } e^2} \times k\sqrt{\text{mean of } e^2}$ is then k (mean of e^2). This is (r.m.s. e) (r.m.s. i) or the product of the r.m.s. volts and r.m.s. amperes.

Now consider the average watts. The instantaneous watts are ei or e (ke) or ke^2. The average of this is (mean of ke^2) or k(mean of e^2) which is the same expression as we got for the product of the r.m.s. values.

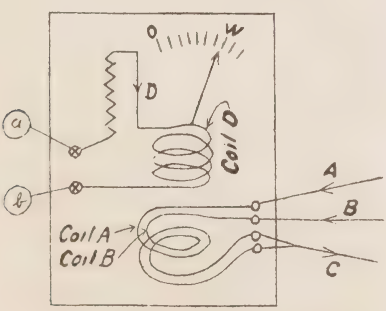


FIG. 17A Ditto with Twin wound Current Coil.

Since the product of the r.m.s. amperes and the r.m.s. volts is the average watts for current and voltage in step, the r.m.s. values are used to designate the values of a.c. amperages and a.c. voltage.

27. Power Factor

The case just cited of amperes and volts in step, represents what is called unity power factor. That is, the ratio of watts to r.m.s. volts times r.m.s. amperes, is unity.

When the amperes are not in step with the volts, then the watts are not the product of r.m.s. volts and r.m.s. amperes.

In this case, the power factor is defined as the ratio of watts to volt-amperes where volt-amperes is the product of r.m.s. volts and r.m.s. amperes.

This same ratio known as power factor will be shown later to be equal to the cosine of the angle of lag of the current behind the volts (or lead ahead of the volts) for single phase circuits.

28. Cosine of Angle of Current Lag

Figs. 17 and 18 are space and time diagrams of a moving coil wattmeter in which the total current C is not in step with the voltage (a − b) but lags it. The current is shown made up of two components A and B where A is in step with the voltage (a − b) and B is in lagging quadrature with it.

Fig. 17A shows the same wattmeter

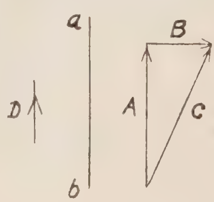


FIG. 18 Time Diagram Moving Coil Wattmeter

with its current coil (or fixed coil) wound with twin wire. This current coil has a total instantaneous flow of current at all times the same as the instantaneous flow in a single coil Fig. 17, hence the torque effect is the same.

The member of this twin coil marked coil A carries the in step component A, and the coil B carries the lagging quadrature, component B.

Fig. 19 shows curves of the currents A and D in step with each other and also the curve of torque which is the curve of the product of the ordinates of A and D. Since the ordinates are never of opposite sign to each other, then their product (the torque) is never negative, and has a definite positive average value.

Note that the torque goes through two cycles while the current goes through one.

Fig. 20 shows the same quantities for coils B and D. Here the currents are in quadrature, and during half the time they are of opposite sign to each other and hence their product (the torque) is negative during half the time and the average torque is zero.

The watts due to the quadrature component B, are then zero, and this quadrature component is called the "Wattless component of the current".

The sum of these two average torques (Figs. 19 and 20) is the same as the torque from A and D Fig. 19, alone because the average torque

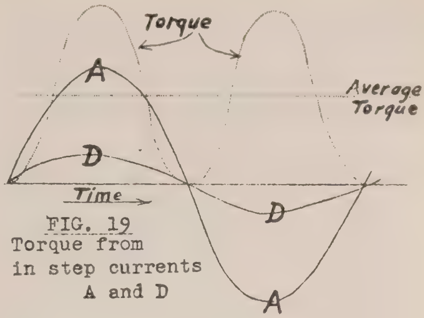


FIG. 19
Torque from in step currents A and D

from B and D Fig. 20 is zero. This total torque (as shown under heading 24) measures the total watts.

Thus we see that the total watts represented by the current C and voltage (a−b) Fig. 18, is the same as the watts represented by the "in step" component A, and the voltage (a−b).

The lag of C behind A is the angle of lag, and A/C is the cosine of this angle of lag, as shown in Fig. 18.

The power factor was defined as the ratio of the watts to the volt-amperes. In this case, these total watts are measured by the volt amperes of A and (a−b), while the volt amperes of the total circuit are measured by the product of C and (a−b). The power factor is then the ratio of A(a−b) to C(a−b) or A/C or cosine of the angle of lag.

Note that if a customer is not drawing power at unity power factor, then enough current to do the work must be taken, so that its in step component

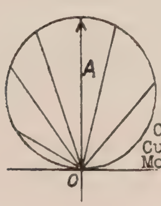


FIG. 18A
Torque versus Current lag Curve for Moving Coil Wattmeter.

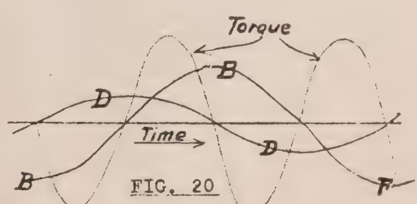


FIG. 20
Torque from quadrature currents B and D.

alone A represents the useful watts or work required. The component B is useless and expensive for the power company to supply, and is the cause of various limitations to the amount of load that certain generators and transmitting apparatus can deliver and get paid for as revenue. Hence the desirability of encouraging the customer to take what steps he can to maintain a high power factor of his load, and the necessity of penalizing him for low power factor.

29. Torque Versus Lag-Curve of moving Coil Wattmeter

A polar torque versus lag curve is plotted in Fig. 18A for constant amperes and constant volts but varying lag.

The lines radiating from 0 have lengths representing the wattmeter torque which is a constant times the cosine of the angle of lag, or the angle from the vertical position in Fig.18A. The curve is seen to be a circle through the origin 0.

Continued in June Number.

An Appreciation of Estimators

By A. S. L. Barnes, Asst. Engineer, H.E.P.C. of Ont.

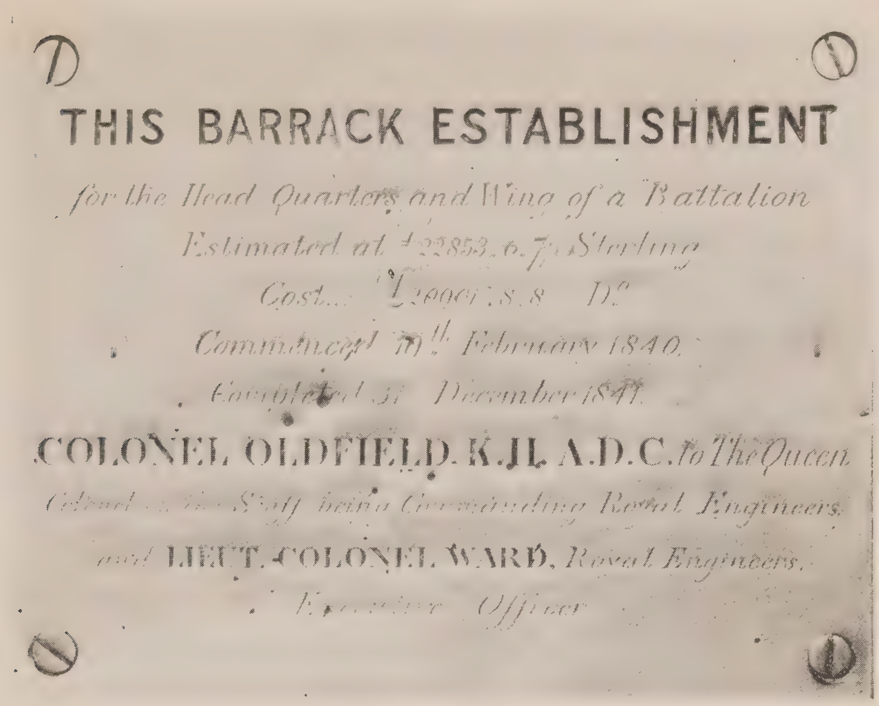
ESTIMATES:—Estimates of cost of power—estimates of replacement value—estimates of life of structures—estimates of future power requirements—estimates of rainfall and runoff. Estimates yesterday—estimates tomorrow—take the data home with you to work out estimates at night.

For some members of the staff of the Hydro-Electric Power Commission and other engineering organizations, it is always estimates—may the "esteem" in which they are held by their fellows be as near to their true worth as are their own estimates to the actual resulting costs!

There will always be opportunities for those unfamiliar with the calculations of expectancies and with the difficulties of assembling all items bearing on the cost of work to say—"It is an engineer's guess!": in certain particulars the experience of the estimator may not of course be sufficiently extensive, but estimates are not usually guesses; in fact, it is seldom so.

In the case of estimates and appropriations for the establishment of the military depot of Her Most Gracious Majesty Queen Victoria, at Stanley Barracks, Toronto, these were certainly not mere "engineer's guesses". A Tablet which was only recently removed from the east entrance to these buildings and which has been polished every morning for nearly 90 years, but seldom read, bears silent witness to that fact.

It is indeed unusual to see a memorial which perpetuates what was evidently excellent work on the part of a humble estimator but this seems to be the purport of the record. So fas as it can be deciphered, after a lapse of nearly a century, the Tablet reads:—



Brass Tablet recently removed from East Entrance to Stanley Barracks, Toronto

THIS BARRACK ESTABLISHMENT
for the Head Quarters and Wing of a Battalion
Estimated at £22853, 6, 7½ Sterling
Cost.... £ 20901, 8, 8. D°.
Commenced 19th February, 1840
Completed 31st December, 1841.
COLONEL OLDFIELD
K.H., A.D.C., TO THE QUEEN
Colonel on the Staff being Commanding Royal Engineers, and LIEUT.-COLONEL WARD, Royal Engineers,
Executive Officer.

The Royal Engineer was well, but not excessively, within his estimate, as became a loyal officer of good Queen Victoria and he was justly proud of it. He was also meticulously careful to report the last farthing of expense. A photograph of the Tablet is reproduced herewith.

This is a good example for engineers to emulate and will be appreciated by those who can realize the difficulty of estimating the numerous items of expense for complicated works, involving knowledge of many trades and materials, in a country which was, in all probability, quite new to the estimator.

Large Electrical Systems

THE supplementary tabulations accompanying May 3, 1930, issue of the *Electrical World*, give statistics of the use of electricity in North America for the year 1929. These data show the total output of each system on the continent where that output exceeded 100,000,000 kilowatt-hours during the year, as also the amounts generated or purchased, and the maximum loads and generating capacities, whether by fuel burning plants or hydraulic. Of such systems there are shown to be 137 in the United States, 14 in Canada, 4 in Mexico, and 15 electric railways or electrified railroads, which latter are also all located in the United States.

The system showing the greatest total output is that of the Niagara-Hudson Power Corporation with a total of 7,212,743,072 kilowatt-hours. This Corporation is shown to have 386,546 kilowatts of generators in fuel-burning plants, and 944,445 kilowatts of hydraulic-driven.

Next in order is the system of the Hydro-Electric Power Commission of Ontario with a total output of 5,071,853,732 kilowatt-hours, and a hydraulic-driven generator capacity of 821,391 kv-a. Other Canadian systems having total outputs exceeding 1,000,000,000 kilowatt-hours are:

The Shawinigan Water & Power Co.	3,726,436,341	kw-hr.
The Duke-Price Power Co., Limited	2,093,829,000	"
Canadian Hydro-Electric Corporation Limited	2,090,788,460	"
Montreal Light, Heat & Power Consolidated	1,568,864,226	"

The total output in each case is the sum of the kilowatt-hours generated and purchased. For the Niagara-Hudson Power Corporation, 6,171,107,190 kilowatt-hours are shown as generated, and 1,041,635,882 kilowatt-hours purchased. The Hydro-Electric Power Commission of Ontario is shown to have generated 4,356,816,109 kilowatt-hours, and purchased 715,037,623 kilowatt-hours.

The tabulations give considerable data concerning the distribution of the power in the United States and also the number of consumers served according to different classifications. Based on these data a tabulation is shown giving the average kilowatt-hours used per consumer, from which we quote the following for residential users.

Geographical Region	*Kw-hr.*
United States	492
New England	415
Middle Atlantic	441
East North Central	526
North West Central	501
South Atlantic	520
East South Central	440
West South Central	415
Mountain	556
Pacific	635

Similar data for 1929, as to the distribution of power by the utilities supplied by the Hydro-Electric Power Commission of Ontario, are not as yet available. The average use under the Commission for the year 1928 by residential users was 1368 kw-hr. and there is reason to believe the use during 1929 was higher.

A.I.E.E. Summer Convention

THE Summer Convention of the American Institute of Electrical Engineers will be held this year for the first time in Toronto. The Royal York Hotel has been chosen as the convention headquarters, the dates being June 23-27, 1930

A selection of excellent technical papers covering various phases of the electrical industry has been made from a wealth of material. This material will be presented in eight technical sessions as follows: Protective Devices—Symposium on Transmission Line Relays III; Transportation; Automatic Stations; Selected Subjects and Technical Committee Reports; Transmission; Symposium on Coordination of Line, Station, and Apparatus Insulation; Communication; and Electrical Machinery and Power Generation.

The annual reports of the Technical Committees of the Institute will review the advances in theory and practice throughout the year.

The business side of the Convention will include the Annual Meeting of the Institute, a report of the Committee of Tellers on election of officers for 1930-1931, and a report on Constitutional Amendments, the President's Address and presentation of prizes for papers.

The Conference of Officers and Delegates, under the auspices of the Sections Committee and Committee on Student Branches, constitutes an important feature of the convention.

The Lamme Medal, awarded several months ago, will be presented to Mr. R. E. Hellmund, East Pittsburgh, Pa., "for his contributions to the design and development of rotating machinery."

On Wednesday there will be a Directors' Luncheon and meeting.

The program leaves nothing to be desired, both from the standpoint of professional benefit and of general social enjoyment. The Meetings and Papers Committee have prepared a schedule of papers covering a wide diversity of interest, the local Convention Committee has arranged a series of events which will provide interest and pleasure for all available time throughout the entire Convention. Particularly should it be noted that the following program calls for the Convention to get into full swing on Monday morning; members are urged to arrive early and register promptly.

OUTLINE OF PROGRAM

(Eastern Daylight Saving Time)

MONDAY, June 23rd

9.00 a.m. Registration.

10.30 a.m. Annual Business Meeting of the Institute.

Address of Welcome.

Annual Report of Board of Directors (in abstract), F. L. Hutchinson, National Secretary.

Report of Tellers' Committee on

(a) Election of Officers; Introduction of and response from President-Elect.

(b) Constitutional Amendments.

Presentation of Prizes for Papers.

Presidential Address, Harold B. Smith.

2.00 p.m. Officers' and Delegates' Conferences.

Qualifying Round for Mershon Trophy.

Tennis.

Ladies' Drive to Granite Club.

4.30 p.m.—Afternoon Tea.

9.00 p.m. President's Reception—dancing.

TUESDAY, June 24th

9.00 a.m. Registration.

9.30 a.m. Two Technical Sessions: (a) Protective Devices (Symposium on Transmission Line Relays III); (b) Transportation.

12.30 p.m. Section and Branch Delegates' Luncheon.

2.00 p.m. Officers' and Delegates' Conferences—continued Trips as scheduled.

Sports as scheduled—First Round for Mershon Trophy.

Ladies' Trip around Harbor.

4.30 p.m. Afternoon Tea at Royal Canadian Yacht Club.

7.00 p.m. Get-Together Dinner and Entertainment.

WEDNESDAY, June 25th

9.30 a.m. Three Technical Sessions, (c) Automatic Stations; (d) Selected Subjects and Technical Committee Reports; (e) Transmission.

11.00 a.m. Ladies' Trip to Mississauga Golf Club, where luncheon will be served.

12.30 p.m. Directors' Luncheon and Meeting.

2.00 p.m. Trips as scheduled.

Sports as scheduled—Second Round for Mershon Trophy.

Ladies' Golf and Bridge at Mississauga Golf Club.

4.30 p.m. Afternoon Tea.

7.00 p.m. Convention Banquet.

8.15 p.m. Medal Presentation.

9.30 p.m. Dancing—Cards.

THURSDAY, June 26th

9.00 a.m. Boat leaves for trip to new Welland Canal.

Lunch at St. Catharines.

2.00 p.m. Inspection of Welland Canal.

Trips to Queenston and Niagara Falls.

Finals—Golf and Tennis.

9.00 p.m. Dancing on boat.

FRIDAY, June 27th.

9.30 a.m. Two Technical Sessions; (f) Electrical Machinery and Transmission (Symposium on Coordination of Line, Station, and Apparatus Insulation); (g) Communication.

12.30 p.m. Luncheon—Presentation of Prizes.

2.00 p.m. Technical Session; (b) Electrical Machinery and Power Generation.

Ladies' Trip to Old Mill—Golf.

4.30 p.m. Afternoon Tea.

TENTATIVE TECHNICAL PROGRAM

(Eastern Daylight Saving Time)

TUESDAY, June 24th

9.30 a.m. Parallel Sessions A and B.

A. PROTECTIVE DEVICES—SYMPOSIUM ON TRANSMISSION LINE RELAYS III.

The Problem of Service Security in Large Transmission Systems, Paul Ackerman, Consulting Electrical Engineer.

Transmission Line Protection, H. P. Sleeper, Public Service Electric & Gas Co.

New Features in Relay Protection, O. C. Traver, General Electric Co.

New Directional Relay Schemes, E. E. George and R. H. Bennett, Tennessee Electric Power Co.

High-Speed Protective Relays, L. N. Crichton, Westinghouse Electric & Mfg. Co.

B. Transportation

Electric Power Consumption for Yard Switching, P. H. Hatch, N.Y., N.H. & H.R.R. Co.

Control Systems for Oil and Gasoline Electric Locomotives and Cars, N. L. Freeman, Westinghouse Electric & Mfg. Co.

Electric Transmission and Control of Power from Internal Combustion Engines for Transportation, S. T. Dodd, General Electric Co.

Auxiliaries for High-Voltage Direct-Current Multiple Unit Cars, C. J. Axtel, General Electric Co.

Summary of Experience of Various Railways with Rail Bonds, H. F. Brown, N.Y., N.H. & H.R.R. Co.

Auxiliary Circuits for High-Voltage D-C. Motor Car Equipments, O. K. Marti and W. A. Giger, American Brown Boveri Co., Inc.

WEDNESDAY, June 25th

9.30 a.m. Parallel Sessions C, D and E

C. Automatic Stations

A Vacuum Tube Telemetering System, A. S. Fitzgerald, General Electric Co.

Development of a Two-Wire Supervisory Control System with Remote Metering, R. J. Wensley and W. M. Donovan, Westinghouse Electric & Mfg. Co.

Centralized Control of System Operation, J. T. Lawson, Public Service Electric & Gas Co.

Automatic Power Supply of the Carnegie Steel Company, Robert Harry, Carnegie Steel Co.

1,000-Kw. Automatic Mercury Arc Rectifier Substation of the Union Railway Company, New York, W. E. Gutzwiller and Otto Naef, American Brown Boveri Co.

Modernization of the Design of Operating Switchboards, Philip Sporn, American Gas & Electric Co.

D. Selected Subjects and Technical Committee Reports

Rural Line Construction in Ontario, R. E. Jones, Hydro-Electric Power Commission of Ontario.

Mutual Impedance of Ground-Return Circuits — Some Experimental Studies, H. E. Bowen, American Telephone & Telegraph Co., and C. L. Gilkeson, National Electric Light Association.

Theory and Characteristics of Grid-Controller Glow and Arc Discharge Tubes, D. D. Knowles and S. P. Sashoff, Westinghouse Electric & Mfg. Co.

Effects of the Magnetic Field on Lichtenburg Figures, C. E. Magnusson, University of Washington.

A Survey of Room Noise in Telephone Location, W. J. Williams, National Electric Light Association, and R. G. McCurdy, American Telephone & Telegraph Co.

E. Transmission

The 220,000-Volt System of the Hydro-Electric Power Commission of Ontario, E. T. J. Brandon, Hydro-Electric Power Commission of Ontario.

Steady-State Theory of Transmission Lines, T. R. Rosebrugh, University of Toronto.

Study of the Effect of Short Lengths of Cables on Travelling Waves, K. B. McEachron, General Electric Co.; J. G. Hemstreet, Consumers Power

Co., and H. P. Seelye, Detroit Edison Co.

Buried Distribution Type Transformers, C. E. Schwenger, Toronto Hydro-Electric System.

FRIDAY, June 27th

9.30 a.m. Parallel Sessions F and G.

F. ELECTRICAL MACHINERY AND TRANSMISSION SYMPOSIUM ON CO-ORDINATION OF LINE, STATION, AND APPARATUS INSULATION

Rationalization of Station Insulating Structures with Respect to Insulation of Transmission Lines, C. L. Fortescue, Westinghouse Electric & Mfg. Co.

Rationalization of Station Insulating Structures with Respect to Insulation of Transmission Lines, F. W. Peek, General Electric Co.

Rationalization of Transmission Line Insulation Strength, Philip Sporn, American Gas and Electric Co.

Recommendations on Balancing Transformer and Line Insulation on Basis of Impulse Voltage Strength, V. M. Montsinger, General Electric Co., and W. M. Dann, Westinghouse Electric & Mfg. Co.

Co-ordination of Insulation as a Design Problem, G. D. Flyod, Hydro-Electric Power Commission of Ontario.

Standards of Insulation and Protection for Transformers, J. A. Johnson, Buffalo, Niagara and Eastern Power Corp., and E. S. Bundy, Niagara, Lockport & Ontario Power Co.

Essential Factors in the Co-ordination of Line, Station, and Apparatus Insulation, A. E. Silver and H. L. Melvin, Electric Bond and Share Co.

G. COMMUNICATION

Long Distance Cable Circuit for Program Transmission, A. B. Clark, American Telephone & Telegraph Co., and C. W. Green, Bell Telephone Laboratories, Inc.

Transmission Characteristics of Open Wire Telephone Lines, E. I. Green, American Telephone & Telegraph Co.

Study of Telephone Line Insulators, L. T. Wilson, American Telephone & Telegraph Co.

General Switching Plan for Telephone Toll Service, H. S. Osborne, American Telephone & Telegraph Co.

Long Telephone Lines in Canada, J. L. Clarke, Bell Telephone Company of Canada.

Two-Way Television, H. E. Ives, Bell Telephone Laboratories, Inc.

2.00 p.m. Session H.

H. ELECTRICAL MACHINERY AND POWER GENERATION

Effects of Lightning Voltages on Rotating Machines and Methods of Protecting against Them, F. D. Fielder and E. Beck, Westinghouse Electric & Mfg. Co.

Effect of Voltage Surges on Rotating Machinery, E. W. Boehne, General Electric Co.

Vertical Shaft 25,000 Kv-a. Synchronous Condensers, H. A. Ricker, J. R. Dunbar and R. E. Day, Canadian Westinghouse Co.

Metal-Clad, Gum-Filled Switching Equipment, L. B. Chubbuck, Canadian Westinghouse Co.

East River Generating Station of the New York Edison Company, C. B. Grady, W. H. Lawrence, and R. H. Tapscott, New York Edison Co.

Hydro Power Practice in Central Europe, A. V. Karpov, Aluminum Company of America.

Association of Municipal Electrical Utilities

Minutes of Executive Committee Meeting

A meeting of the Executive Committee of the A.M.E.U. was held at the office of the Hydro-Electric Power Commission of Ontario, Toronto, on April 23rd, beginning at 2.00 p. m. The following Executive Committee members were present: Messrs. R. L. Dobbin, Chairman, J. E. Teckoe, A. W. J. Stewart, O. H. Scott, R. M. Bond, C. T. Barnes, J. R. McLinden, J. E. B. Phelps, J. W. Peart, T. W. Brackinreid, E. V. Buchanan, T. J. Hannigan, S. R. A. Clement.

It was moved by Mr. E. V. Buchanan and seconded by Mr. O. H. Scott, That the minutes of the previous Executive Committee meeting be taken as read.—*Carried.*

The Secretary advised of having received a communication from E. W. Playford, Limited, making application for commercial membership. It was moved by Mr. O. H. Scott and seconded by Mr. J. W. Peart, That the application of the E. W. Playford, Limited, for commercial membership be accepted.—*Carried.*

Mr. E. V. Buchanan, Chairman Papers Committee, presented a report from that Committee suggesting papers to be given at the Summer Convention of the Association. One paper to be given at a short session on the afternoon of Monday, July 7th, and two papers at each of the sessions on Tuesday and Wednesday mornings, July 8th and 9th. The papers suggested were as follows:

(1) Range and appliance connections.

(2) Low voltage distribution network.

Paper to be given by Mr. D. K. Blake, Central Station Engineering Department of the G. E. Company, Schenectady

(3) Hydro progress, past, present and future.

(4) Laboratory data in connection with paints, oils, etc.

Paper to be given by some one from the Laboratory.

(5) Merchandising, with a view to revenue and load building.

Paper to be given by Mr. G. W. Hague of Campbell-Ewald Company.

Mr. Buchanan moved the adoption of this report which was seconded by Mr. T. W. Brackinreid. In discussion of report Mr. Bond drew attention to the desirability of arranging for a paper or discussion regarding certain details in utility accounting and asked that arrangements be made in the program for such paper or discussion. Messrs. Buchanan and Brackinreid revised their motion to include Mr. Bond's suggestion, Mr. Bond having undertaken to arrange this detail, after which the resolution was carried.

Mr. J. W. Peart, Chairman Convention Committee, presented a report from that Committee regarding proposed entertainment during the Convention, which is outlined briefly as follows:

MONDAY, JULY 7th

Morning .

Registration on board boat and at hotel, after arrival of boat.

Afternoon :

1.30—Short business session.

3.30—Sports and recreation.
Ladies' Bridge.

Evening :

9.00—Convention Dance.

Luncheon and dinner on this day will be partaken of at the convenience of the delegates, there being no speaker.

TUESDAY, JULY 8th

Morning :

9.30—Business session.

Afternoon :

12.30—Convention luncheon with speaker.
Sports and recreation and boat ride.

Evening :

6.30—Convention dinner with speaker followed by dance.

WEDNESDAY, JULY 9th

Morning :

9.30—Business session.

Afternoon :

12.30—Luncheon. Presentation of prizes and musical program.
Sports and recreation.

The dinner on this evening is to be informal and time given to permit those wishing to leave by boat at 7.00 o'clock to do so.

The Committee also asked the Executive for authority to spend $250.00 for prizes, and $50.00 for incidental expenses in connection with the Convention. The adoption of this report, being moved by Mr. Peart and seconded by Mr. A. W. J. Stewart, was carried.

Mr. Hannigan undertook on behalf of the O.M.E.A. to provide speakers for the luncheon and dinner as outlined in the Convention Committee report.

Reference was made to a resolution adopted at a meeting of the Executive Committee on September 6th, 1928, which was as follows:

> "That this Executive recommend to the O.M.E.A. the advisability of that Association taking up with the Hydro-Electric Power Commission of Ontario, the desirability of using the Canadian National Exhibition as a means of placing the advantages of Hydro before the public of Ontario."

Mr. Hannigan reported that this resolution had been presented but no action taken since no plan had been laid out. After considerable discussion on this subject it was moved by Mr. E. V. Buchanan, and seconded by Mr. O. H. Scott.

THAT the Ontario Municipal Electrical Association be requested to interview the Hydro-Electric Power Commission of Ontario with a view to greater publicity along the following lines:

1. THAT space be obtained at The Canadian National Exhibition where an exhibit can be put up along the lines followed by the Canadian National Railways, the Canadian Pacific Railway, and the Bell Telephone Company with coloured illuminated maps showing the various Hydro systems, and with attendants in charge capable of answering questions concerning Hydro, both urban and rural, and with printed matter for distribution dealing with the progress and various phases of the Hydro System.

2. THAT in our opinion a Hydro

magazine should be issued for distribution to light and power consumers giving information in a manner that may be of interest to laymen and eliminating technical matters. It is felt that sufficient advertising could be secured to make this self-sustaining.

3. THAT in view of the fact that many radio stations are being operated by private concerns and others for their advantage, we feel the Hydro-Electric Power Commission of Ontario should take advantage of the opportunity to broadcast the Hydro story at frequent intervals. We feel that the Municipal Commissions and Hydro consumers generally are not being kept as closely in touch as we believe advisable in the continued interest of Hydro progress.—*Carried.*

A reference was made to a resolution carried at the Winter Convention asking the Executive Committee to appoint a Committee to act with Mr. Dobson and his department in the matter of research.

It was moved by Mr. J. W. Peart, and seconded by Mr. A. W. J. Stewart THAT Messrs. E. V. Buchanan, London C. E. Schwenger, Toronto, and O. M. Perry, Windsor, be named a Committee to assist Mr. Dobson and his department regarding research.–*Carried.*

There being no further business the meeting adjourned at 3.45 p. m.

* * * *

Invitation to the A.I.E.E. Summer Convention

The Secretary has received the following letter from Mr. F. L. Hutchinson, National Secretary, American Institute of Electrical Egineers, and he is taking this means of placing it before the A. M. E. U. Membership.

New York, May 6th, 1930

Mr. S. R. A. Clement, Secretary
Association of Municipal Electrical Utilities
190 University Avenue
Toronto, Ontario

Dear Mr. Clement:

This Institute will hold its Annual Summer Convention at the Royal York Hotel, Toronto, June 23-28, 1930. A copy of the complete program will be mailed to you in the near future; but in the meantime, I desire to extend, through you, to the members of your organization, a cordial invitation to attend any or all of the events of our Convention in which they may be interested.

If you have means of bringing this invitation to the attention of your members, through your publications or otherwise, we shall be glad if you will do so.

With best regards

Very truly yours
(Sgd.) F. L. Hutchinson
National Secretary

O.M.E.A. - A.M.E.U.

Convention at

BIGWIN INN

Lake-of-Bays

July 7, 8 and 9, 1930

Hydro News Items

Central Ontario System

Bowmanville is negotiating for the purchase of the local electric system and it is expected that arrangements will be completed for taking the vote, at an early date.

* * * *

Fifty miles of rural line have been developed in the Napanee Rural Power District this year.

* * * *

Negotiations are proceeding with regard to a supply of power to the village of Hastings. It is anticipated that the construction work necessary to supply Hastings with power will be carried out this year.

* * * *

The village of Madoc is now taking power from this Commission under a cost contract and new rates are being prepared for the Municipality.

* * * *

Madawaska System

The taking over of the O'Brien interests on the Ottawa, by the Commission, has led to requests from rural residents for service in Arnprior Rural Power District and the village of Fitzroy Harbor has requested the Commission to give it service.

Niagara System

In conjunction with the paving of Clarence Street, Port Colborne, all poles are to be removed and the lines placed in underground ducts.

* * * *

The operation and maintenance of the Port Dover System will be handled, from May 1st, by the Commission's Rural staff at Simcoe.

* * * *

An ornamental street-lighting system is being planned for the business section of the town of Dundas.

* * * *

A Rural office and storeroom has been opened in Cayuga to operate the Haldimand and Dunnville Rural Power Districts.

* * * *

Ottawa System

Arrangements have been made to build a line east of Ottawa to the village of Navan in Nepean Rural Power District serving residents in Navan and intervening points.

Golfers Take Notice

The spring issue of "*The Hotpointer*" published by the General Merchandising Department, Canadian General Electric Company, Limited, contains the following item from the pen of A. R. Harper, Editor, which we believe will be of interest to a great many of our readers.

"Here's a bit of interesting news for all of our enthusiastic golfing readers. I say "all" and "enthusiastic" because it can be safely taken for granted that all our readers (or nearly all) are golfers, and the enthusiasm follows as a matter of course.

Hotpoint, wishing to encourage all the electrical fraternity to better golf, has instituted the Hotpoint Hole-in-One Club, and is donating a prize to each golfer in the electrical business in Canada who is successful in making a Hole-in-one, from tee to cup, on any golf course in Canada. The prize will take the form of any one Hotpoint Appliance listing up to $15.00.

The competition is limited to golfers who are engaged in the electrical business in Canada, and entries must be substantiated by a signed and attested score card sent to the writer personally, together with information as to the prize desired. Your nearest C.G.E. branch office will be glad to forward the entry and to assist in the selecting of the prize.

The golf season will soon be in full swing. Make up your mind that you're going to get one of these Hotpoint prizes. Keep your head down, and your eye on the ball. Who's going to be the first to report success?

Beck Memorial Endowment Fund

NOTICE

Public Utility offices having money on hand to the credit of the Beck Memorial Endowment Fund, are asked to forward the same to Dr. F. H. Pratten, Medical Superintendent, The Queen Alexandra Sanatorium, R.R. No. 7, London, Ontario.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

NOTICE

THE new, or 9th edition of the Rules and Regulations governing electrical installations for buildings, structures and premises, Potentials from 0 to 5,000 volts, of the Hydro-Electric Power Commission of Ontario is now available for distribution and may be obtained at any of the District Inspection offices of the Commission, or from the Electrical Inspection Department, Room 408, Northern Ontario Building, Toronto, at 25c per copy.

These Rules will become effective throughout the Province on June 1st, 1930.

Electrical Inspection Department,

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Ottawa Hydro-Electric Commission Substation No. 3

By S. W. Canniff, Electrical Engineer, Ottawa Hydro-Electric Commission

SUBSTATION No. 3 of Ottawa Hydro-Electric Commission at the intersection of Carling Avenue and Merivale Road was completed and put in operation October 1st, 1929. Being at the extreme western boundary of the city, it is to supply light and power to the western section of the city and any extensions the city may make to the West.

The Building

The substation building has a frontage of 104 ft. 6 in., and a depth, including the tower room, of 72 ft. 1 in. The main switchgear room at the front, has inside dimensions of 101 ft. 6 in by 25 ft. 6 in. wide and 21 ft. 6 in. high, with a crane run the entire length of the building equipped with a 3-ton Herbert Morris hand-operated travelling crane.

At the centre of the building and directly back of the main switchgear room with a floor level the same as the basement is the tower room 32 ft. wide by 34 ft. long and 53 ft. 6 in., in height, with a crane run its entire length and equipped with a 30-ton Herbert Morris hand-operated travelling crane. The door of the tower room is 12 ft. 6 in. wide with a clearance of 25 ft. 6 in. and is of the rolling-lift type. The railway siding of the C.N.R. is continued into the tower room to allow all loading, unloading, etc., to be done using the crane under cover.

To the left of the tower room, and with the floor level the same as the main switchgear room, is the control room of the Hydro-Electric Power Commission of Ontario for their equipment and apparatus which is on the same site as this substation. To the right of the tower room and with the same floor level as the main switchgear room is the operator's office. These two rooms are 24 ft. 6 in. by 16 ft.

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June, 1930

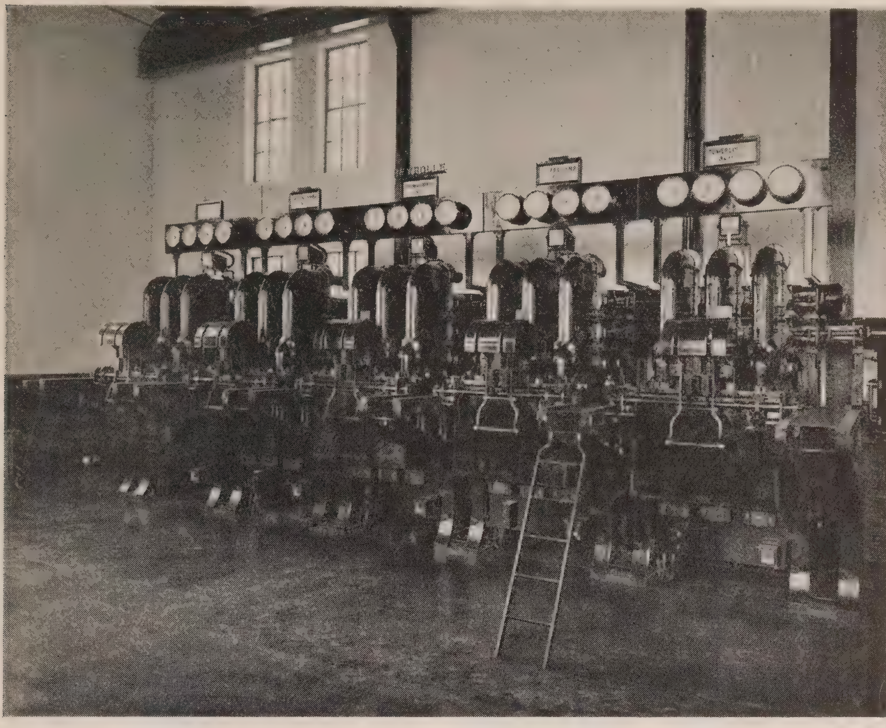
The basement is 8 ft. 6 in. high and extends under the main switchgear room and the two rooms on either side of the tower.

Transformers

The two supply transformers which were manufactured by the Canadian General Electric are installed on concrete foundations and are placed at the back of the building on the opposite side of the track from the 110 kv. transformers of the Hydro-Electric Power Commission of Ontario. Provision has been made for three transformers although only two are installed at present. The transformers are oil-insulated, self-cooled, 3,000 kv-a., 60 cycle, three-phase, 11,000/2,300 volt. The high voltage winding has two 2.5 per cent. taps above and below normal. The tap changing switch mechanism is brought out at the top and can only be operated when the transformer is de-energized. We are using the 2,300-volt delta connection of the transformer secondary at present, although provision is made for 4,000 volt star operation if desired.

The transformers are arranged with cable terminal boxes and the cable sheathes are wiped on to these boxes. The primary is connected to the 11-kv. bus through an oil-circuit breaker by No. 0000, 11,000 volt, three-conductor, lead-covered, paper-insulated cable. The secondary is con-

Ottawa Hydro Substation No. 3



Five panel 11 kv. switchboard

nected to the 2.2-kv. bus through an oil circuit breaker by single-conductor 1,000,000 cir. mils paper-insulated, lead-covered cable.

Switchgear

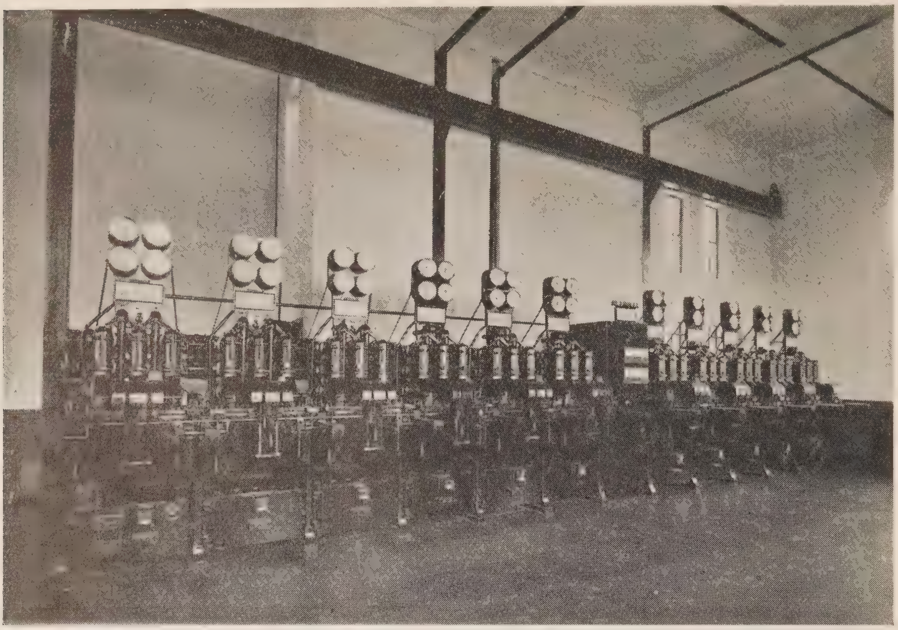
All the switchgear is of the metal clad drawout construction and is mounted in the main switchgear room, consisting of a 5-panel, 11-kv. switchboard, and a 12-panel, 2.2-kv. switchboard. The switchgear was all manufactured by the Reyrolle Company, Hepburn-on-Tyne, England, and was shipped wired, and set up by our own erection department.

The instruments were manufactured by Nalder Bros. & Thompson of London, England, and the relays by the Swedish General Electric. The watt-meters are of the centre-zero type and the relays inverse-time-limit, circuit-opening. The current transformers on the 11 kv. switchgear are double ratio 600-300/5 amperes.

There is a double set of busses at the back of each switchboard. These are embedded in compound as are all the current transformers.

11 Kv. Switchgear

The 11-kv. switchboard is made up of five panels joined so as to form one complete switchboard and each panel is equipped with three ammeters and one watt-meter, three current transformers, one three-phase potential transformer, three relays and one 12,000 volt, 800 ampere, oil circuit breaker with three trip coils. The



Eleven panel 2200 volt switchboard

rupturing capacity of the oil circuit breaker is 500,000 kv-a. The breakers are all provided with removable contacts which allows them to be connected to either bus. The 11-kv. supply is fed into the busses direct and connected by means of cable boxes at either end.

The 11-kv. switchgear is to control the circuits to the primary of the transformers at this station and the 11-kv. feeders to our other substations.

2.2. Kv. Switchgear

The 2.2-kv. switchboard is made up of twelve panels joined together so as to form one complete switchboard. The panels at either end are for the incoming supply from the 3,000 kv-a. transformers. They are each equipped with three ammeters, one voltmeter, and 1–6,600 volt, 3-P.S.T., 1,200 ampere automatic hand-operated, oil-circuit breaker (rupturing capacity 250,000 kv-a.) with three trip coils and two inverse-time-limit overload relays.

There are nine outgoing feeder panels equipped with three ammeters, one volt-meter and one 6,600 volt, 3 P.S.T. 800 ampere, automatic-instantaneous-trip, (3 trip coils) oil circuit breaker (rupturing capacity 250,000 kv-a.). The seventh panel from the left is equipped with two Everett Edgcumbe, model 111, three-phase electrostatic ground detectors, one connected to each bus, and two air-break, 3 P.S.T. disconnecting switches, one connected to each bus, and to a three-phase, oxide-film, lightning arrester in the basement in brick cells. All oil circuit breakers are equipped with automatic shutters to protect the bus contacts when the

breakers are withdrawn and interlocks to prevent the breakers from being removed or replaced when in the closed position.

Each of the 2.2-kv. feeder circuits is of 200 ampere capacity, only five being in use at present, the other four being for use as the demand for power in this section of the city increases. In each feeder is a three-phase, 5 per cent. boost or buck Westinghouse automatic induction-type regulator. The regulators have their current and potential transformers, and all accessories mounted on them and the accessories are protected by steel cabinets.

Disconnecting switches in asbestos-lined steel boxes are installed in all feeders, both 11-kv. and 2.2.-kv. These boxes are locked so only the operator can open or close the switches. The ducts run directly into the basement.

The station service transformers are in the basement in a separate room. They are three 37-½ kv-a., 2,200/110-220 volt, single-phase for lighting and heating and one three-phase, 2,200/220 volt for the control circuit of the regulators and the motor of the oil filterer.

The building is heated by twenty-four 3 kw. Moffat air heaters.

General

The ceilings are painted white, the wall a light blue and the floor a dark brown. The walls up to the window sills are painted the same color as the floor. All iron work including the crane, switchgear, regulators, etc., are painted black. The building is lighted from the ceiling with direct illumination.

During the eight months' operation of the substation we have found the apparatus to be very successful. The double bus arrangement, together with the removable plug contacts on the oil-breakers have proven a very flexible and satisfactory arrangement for our system of operation.

Hydro Float in Shriners' Parades

THE Hydro-Electric Power Commission adopted a very unique way of advertising itself and its activities to visitors to the City during the Shrine Convention, June 11, 12 and 13, 1930, by entering in the various parades which took place an allegorical float of a most unusual design.

The photograph which is reproduced herewith hardly does justice to the float itself because of the impracticability of coloring the photograph as was the float but a brief description of this piece of work may help embellish the reproduction to some extent.

The float is constructed on a specially built steel frame chassis 40 ft. long by 10½ ft. wide. The 4 pieces of statuary and the shell background were built separately in the sculptor's studio in Toronto and mounted on the platform of the chassis after which the water effect was produced and the whole of the upper structure completed.

The statuary is constructed on a

Hydro Float in Shriners' Parades

wooden form very rough in character upon which is formed expanded metal to approximate detail and upon this expanded metal plaster of paris is moulded to the details seen in the reproduction and a very pleasing effect has been produced to illustrate the development of Hydro Power from sources supplied by nature.

The plaster work was colored in a very pleasing manner. The cornucopia was painted a dark blue with gold trimmings and the water was painted green and blue and white. The figures were a pure dazzling white. The shell background was painted in purple tints and the fork lightning was painted a glittering gold. With the illumination and flood lighting effects which were produced on the figures and the shell, the float presented a most striking appearance as it proceeded through the avenue of the parades, particularly at night.

The lower part of the float was intended to illustrate the destiny of the power developed by the Commission. The scenery on the side and back panels is intended to illustrate the industrial and domestic field of distribution and the manner in which this was illustrated produced a very striking effect in that the scenery was cut out and mounted in relief on the side panels which were painted out of shades of blue and green in modernistic style.

The float was drawn by 6 beautiful dappled grey horses loaned to us by the Canadian National Express Company and it was hard to say which presented the most pleasing appearance —the horses or the float.

Many complimentary remarks have been received from all quarters on the turn-out and it is now the intention to place this float on exhibition in the Canadian National Exhibition grounds, possibly in one of the buildings where it will be on display during the Exhibition period and it will possibly take part in parades to which it is suited from time to time.

Practical Use of Vectors in Electrical Work

By H. S. Baker, Meter, Engineer, H.E.P.C. of Ont.

Continued from May Number

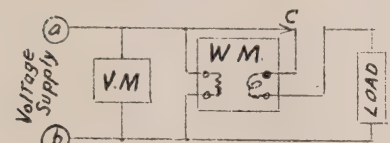


FIG. 21 Space diagram V.M. and W.M.

30. Data from Wattmeter and Voltmeter

Let us now consider a Wattmeter and a Voltmeter connected to a single phase load as per Figs. 21 and 22. We know that the Wattmeter is reading a wattage caused by the product of the voltage (a—b) and the in step component A of the current C.

We will then divide the watt reading by the volt reading and the result is the in step component A of the current C. We do not yet know the value of the quadrature component of C but must take further steps to find it.

Let us picture the information we get from the reading of these two instruments, the wattmeter and the voltmeter on a single phase circuit. Fig. 22 shows vector (a—b) plotted in volts to the r.m.s. volt scale, and also shows the in step component A of the current. It is the watts divided by the volts and plotted to the r.m.s ampere scale in step with (a—b). We now draw a line through the point end of A at right angles to (a—b) and we know that the point end of the unknown vector C of the total current lies somewhere on this line, because C is made up of A and some horizontal or Wattless vector such as B_1, B_2, or B_3.

If we knew that the load was a lagging load, that is, if we knew that the vector C lagged (a—b) then we could insert an ammeter in the current C and knowing the length of the C vector, could lay it off with its tail at the tail of A and its point on the horizontal line to the right of A.

31. Choke Coil and Condenser

Consider next the diagrams 23 and 24 of a choke coil. It will be stated here (without giving any proof) that the current (if not influenced by magnetism from other coils) lags behind the voltage upon its terminals. Iron in the coil in general increases the magnetic effect and increases the amount of lag.

Figs. 23 and 24 show the voltage

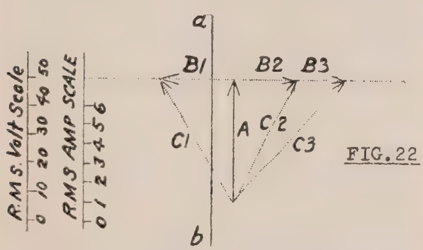


FIG. 22

Time diagram V.M. and W.M.

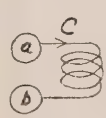


FIG. 23 Space diagram Choke Coil

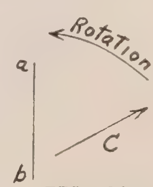


FIG. 24 Time diagram Choke Coil

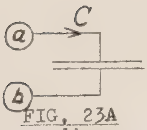


FIG. 23A
Space diagram
CONDENSER

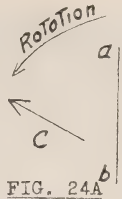


FIG. 24A
Time diagram
CONDENSER

upon, and the current in a choke coil and the current C is shown lagging terminal voltage (a—b).

Figs. 23A and 24A show the same thing for a condenser that 23 and 24 show for a choke coil. Here the current leads instead of lagging.

32. Wattmeter and Choke Coil

We will now insert a choke coil in the voltage circuit of a moving coil wattmeter as shown Fig. 25 and develop the time diagram Fig. 26 of the assembly. This modified wattmeter will be found useful to determine the cyclic order of any given three terminals.

The cyclic order is the order in which the terminals must be named so that they shall reach maximum potential one after the other in the order named. Thus in Fig. 16, as the triangle rotates to the left, we see first a, then b, then c come to the top, or the cyclic order is a, b, c.

This information is sometimes a practical necessity in diagnosing metering and relaying, and a.c. motor connections.

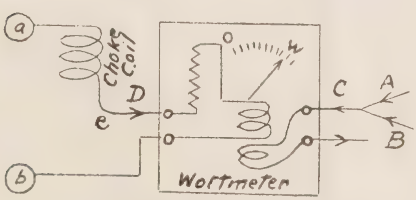


FIG. 25
Space diagram
W.M. and choke coil assembly

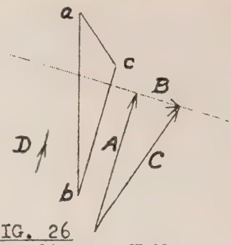


FIG. 26
Time diagram W.M.
and choke coil
assembly

In building up the time diagram of the modified wattmeter assembly we will start from the voltage (c—b) Fig. 25 applied to the wattmeter itself.

This vector (c—b) is then plotted in any direction. The current which is caused to flow by this voltage (c—b) in the ohmic resistance of the wattmeter circuit, is D. This small current D is then plotted parallel to (c—b) because it is in step with (c—b). The small current D is also the choke coil current and must lag the choke coil voltage, (a—c). We then plot (a—c) as shown at an angle leading D. The vector sum of (a—c) and (c—b) is as shown (a—b). We now have the unknown current C which we will show as a vector lagging (c—b) and also show its two components A and B, where we have made A parallel to (c—b) and B lagging it by 90 degrees. The wattmeter reading divided by the voltage (c—b) tells us the value of A and tells us that the end point of current vector C lies somewhere on the dotted line through the point of A which is at right angles to (c—b), as shown in Fig. 22 and 26.

33. Torque Versus Lag-Curve of Wattmeter plus Choke Coil

We wish to draw the torque versus lag curve of this assembly. We have

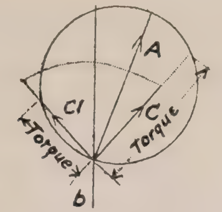


FIG. 26A

Torque versus Lag curve for W.M. and Choke coil Assembly

already drawn a similar curve for the wattmeter alone in Fig. 18A. Fig. 26 shows the fixed angle between the wattmeter voltage (c−b) and the assembly terminal voltage (a−b). This angle is dependent upon the relative values of the choke coil and the wattmeter voltage circuit, and can be easily determined by test if desired. The component of the wattmeter current which is in step with the wattmeter voltage, is A, Fig. 26, and is parallel to (c−b).

If the current C were in the direction of A, then the angle of lag in the wattmeter would be zero, and its cosine would be unity, or at maximum value. We have drawn the torque in Fig. 26A at maximum value in the direction of A. The torques in the other directions are drawn equal to the maximum torque, times the cosine of the angle between the other directions and the direction of A because this angle is the angle of lag upon wattmeter alone. The end points of all the torque lines form a circle with its maximum value along A, which is leaning to the right from the assembly terminal voltage (a−b).

Let us consider the torques in the directions C and C_1 in Fig. 26 A, which are at equal angles behind, and ahead, of the assembly terminal voltage (a−b). We see that the torque in the C direction is larger than the torque in the C_1 direction. This difference of torques will be made use of later to determine whether one voltage lags or leads another, and to determine cyclic order.

If the choke coil were not used, then the wattmeter would show equal torques for the similar lag and lead angles. This can be seen in Fig. 18A, where the torque versus lag circle does not lean to the right.

34. Cyclic Order Test Routine

There are many ways of determining cyclic order but the method to be described involves only the carrying of a small and simple choke coil in addition to regular meter testing equipment to do the job. In fact the potential circuit of any of the induction type meters on the switchboard will answer very well as a choke coil and in this case no extra equipment is required to take cyclic order.

We will now refer to Figs. 15 and 16 as space and time diagrams of the three terminals of which we are going to determine the cyclic order. Note by Fig. 16 that we are not assuming even approximately balanced voltage.

Fig. 27 shows the diagram of connections where the "plus or minus" current terminal and the "plus or minus" potential terminal are connected to one terminal of the voltage supply that we choose to call "b". We may choose to call any of the three, "b", and then determine by test which of the remaining two to call "a" so that the cyclic order may read "a"−"b"−"c".

Note that the letters a, b, c, used to indicate cyclic order will not identify which legs may be called a,

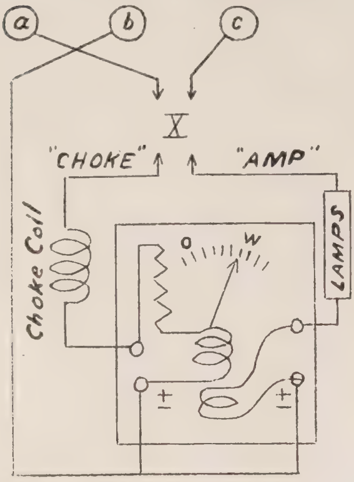


FIG. 27
W.M. and CHOKE
for taking cyclic order

b, and c, at some other part of the system, because we have arbitrarily chosen one of the legs to call "b". When we find by test which terminal reaches maximum plus potential immediately before b, does, then we will call that "a". The one that follows b, will be called "c". Then the order in which the terminals become plus is, a, b, c, or it is b, c, a, or it is c, a, b. It is not c, b, a.

The connection from the choke coil as shown Fig. 27, is called "choke" and is going to determine the "c" terminal when we have made the proper connections at the point X. The connection feeding amperes to the wattmeter is called "amp" and is going to determine the "a" terminal. Note the "c" and the "a" are the initials of the "choke" and the "amp" lead. After wiring up per Fig. 27, then make the connections at X first straight and then crossed. Note the wattmeter readings for the two connections and choose the larger reading. Reconnect at X to give the larger reading and then the "amp" lead will be connected to the "a" terminal, and the "choke" lead to the "c" terminal.

If the choke coil is omitted, then the two wattmeter readings will be alike in spite of the difference in voltages, because, in interchanging the leads at X we reduce the voltage applied to the lamps from the higher voltage (c—b) to the lower voltage (a—b) and at the same time we increase the voltage applied to the potential circuit in a similar ratio. The presence of the choke coil makes the difference in the readings very marked. A considerable difference, however, between the voltages (c—b) and (a—b) has very little effect upon the difference of readings, for the reason given above.

35. Analysis of Cyclic Order Test

Let us now see why the above difference in readings occurs. With the connections at X crossed, we have the (a—b) voltage feeding through the lamps and supplying the current to the current coil of the wattmeter. This current is in step with the applied voltage (a—b) because the lamps are an ohmic resistance. We also have the potential (c—b) applied to the potential circuit of the wattmeter and choke assembly. Here (a—b) Fig. 16 lags (c—b) Fig. 16, hence the amperes produced by (a—b) are lagging the volts (c—b) and we have the condition represented by the direction C in Fig. 26A and the torque is high, giving a high reading.

When, however, we connect straight through at X, we have the current

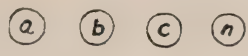


FIG. 28
SPACE - 4 wire
3 phase Voltages

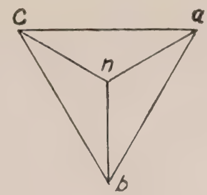


FIG. 29
TIME - 4 wire
3 phase Voltages

leading the voltage and get the condition represented by the direction C_1 Fig. 26A when the torque is small.

36. Cyclic Order of 120 Degree Triangle

Fig.29 and Fig. 28 show the three line voltages and also the neutral as met with in four wire three phase loads. The metering voltage may be fed from only a, n, and c. The voltage (a—c) will be 73 per cent. greater than (a—n) or (c—n) as shown Fig. 29.

We may have to take cyclic order on a, n, and c which is a 120 degree triangle without having b available to connect to.

Voltmeter readings will identify which of the three is n. This n, we will connect in as we did b in Fig. 27 for the balanced voltage supply. Both watt readings will now be negative and we must reverse say the current connections to the wattmeter.

The smaller deflection is now the more plus reading because both readings are negative. We then fix upon the connection at X giving the smaller instead of the larger deflection and find the "amp" lead connected to "a" and the "choke" lead connected to c.

37. "Right and Left Readings"

This is a system of determining the phase direction and magnitude of a

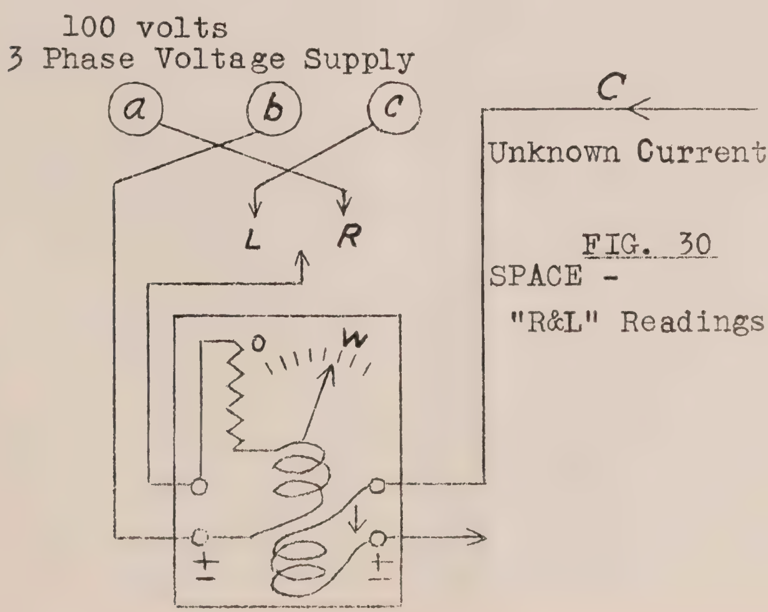
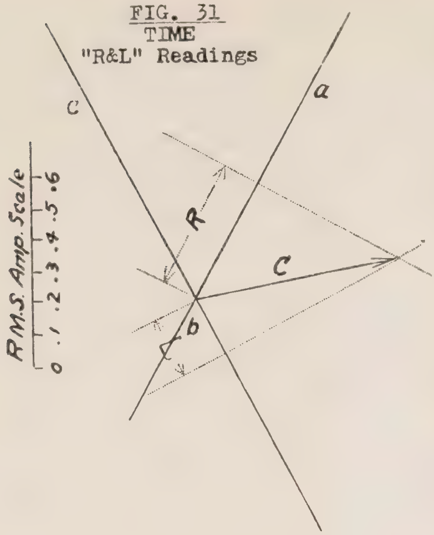


FIG. 30
SPACE -
"R&L" Readings

FIG. 31
TIME
"R&L" Readings



given unknown current in relation to a known voltage triangle. It has been used by the writer for about 18 years and is now used in various forms by metering inspectors. It is sometimes called "crossed Wattmeter readings". The three phase voltage supply a, b, c, Fig. 30 may be of known cyclic order and may be known to be balanced. If there is any doubt, it can be measured as to unbalance by a voltmeter and its cyclic order may be taken. We will take the case of a balanced supply where (a−b) Fig. 31 lags (c−b) by 60 degrees.

The wattmeter is connected to the R connection as shown Fig. 30 with the unknown current C feeding through the wattmeter current coil. We have placed an arbitrary positive direction arrow on the unknown current and have fed the current through the Wattmeter as shown with the positive direction inside the meter towards the "plus or minus" current post. Note also that the common potential connection is to the "plus or minus" potential post. The wattmeter reading is taken in the R connection. Say the reading is plus 40 watts. Now change to the L connection and read the wattmeter again. It may try to read backwards. If so, reverse the potential leads and take the reading and call it a negative reading. Say the reading is minus 20 watts. If the voltage is 100 volts, then the in step components of the two watt readings are plus 40/100 and minus 20/100 in r.m.s. amperes.

This is repeating what we did in Fig. 22. We then draw a line at right angles to (a−b) Fig. 31 as determined by the "Right" reading and we know the point end of the unknown current vector C is on this line. We then draw the line at right angles to (c−b) as determined by the "Left" reading and we know the point of C is also on this line. It must then be on the intersection of these two lines and we can plot the vector C as shown Fig. 31. This vector C has a component in step with (a−b) of plus 40/100 and a component in step with (c−b) of minus 20/100 amperes as can be seen in Fig. 31.

Ordinarily we are interested in phase direction and in relative magnitudes of amperages only and in that case we do not trouble to divide the

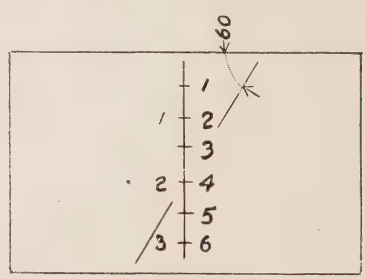


FIG. 32
Transparent Scale for
Vector Plotting

watt readings by the voltage to get ampere component readings. We assign a scale of watts and plot the watt readings as read. The lengths of the current vectors in this case would be volt-ampere quantities measured to the watt scale.

The laying off of the 60 degrees angle, a, b, c, Fig. 31, and the plotting of the distances "R" and "L" and the scaling off of the value of C can be very conveniently done by the use of a transparent celluloid scale shown Fig. 32 which can be made pocket size and be large enough for approximate plotting.

If the voltage triangle is not balanced and we wish accurate results, we must measure the voltages $(a-b)$, $(b-c)$, and $(c-a)$ and plot the triangle to determine the angle at b and use it instead of the 60 degrees generally used. The cyclic order also should be checked. In this case the R wattmeter reading must be divided by the $(a-b)$ voltage to get the in step ampere component of C, and the Left wattmeter reading must be divided by $(c-b)$.

Right and Left readings can be taken upon an unknown current, using only a single phase reference voltage if an extra terminal is brought out on the wattmeter from the junction of the wattmeter moving coil and the wattmeter resistance. A choke coil may be connected to this terminal which is adjusted to pass the same current through the moving coil as the resistance does. The two readings are taken with, first the resistance alone in, and then the choke coil alone in. The reference angle a, b, c, Fig. 31 must be determined once for all from a test on the assembly.

38. Polarity Markings

On apparatus such as wattmeters, potential transformers, power transformers, and current transformers, having two or more separate circuits, there are generally some kind of marks placed on electrically similar ends of the various circuits. The meaning of electrically similar ends may be defined as follows:—

A potential transformer has a high voltage winding whose terminals we will call H_1 and H_2 and the vector (H_1-H_2) (not shown) represents this voltage. We will call the low voltage terminals X_1 and X_2. One of the low voltage terminals rises and falls in potential in step with the rise and fall of H_1. This low voltage terminal we will call X_1 and will call the other X_2. H_1 and X_1 are then similar ends. Sometimes the only polarity marking will be a daub of red paint at H_1 and another at X_1.

If we traced the two conductors from the two red daubs, into the transformer we would find that both conductors travelled through the iron of the transformer in the same direction.

The same thing applies to current transformers with polarity markings. Here, as with all transformers, while the marked terminals rise and fall in potential together, yet the instantaneous current flow is into the transformer at one marked terminal, while it is out at the other marked terminal.

If the marked leads are geographically at opposite ends of the two circuits, then the polarity is said to be "additive" and if they are at geographically similar ends the transformer polarity is said to be "subtractive".

A power transformer is treated the same as a potential transformer.

Wattmeter terminals have polarity markings called "plus or minus" signs. These are shown in Fig. 17.

If the instantaneous amperes flow into the wattmeter at the unmarked current terminal, at the same time that the unmarked potential terminal is at a higher (or more plus) potential than the marked potential terminal, then the wattmeter will deflect up scale.

39. Reactive Volt-Amperes

In Figs. 17 and 18 we saw that the watts were the product of the in step component A, of the current C, times the voltage (a−b). This wattage might be called "The in step volt-amperes".

The "Reactive volt-amperes", is the product of the reactive (or quadrature) component B of the total current C, with the voltage (a−b).

If a voltage is applied to the wattmeter equal to (a−b), but lagging it by 90 degrees, then B becomes the component of C which is in step with the applied voltage, and the wattmeter will read B times the applied volts (a−b), which product, is the reactive volt-amperes, and the wattmeter becomes a "reactive volt-ampere meter"

Since B is equal to C times the sine of the lag angle, then the reactive volt-amperes are equal to, the volts

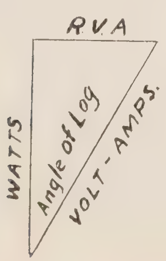


FIG. 33
Components of
Volt-Amperes

(a−b) times the total amperes. C times the sine of the lag angle.

The relationship between watts, volt-amperes, reactive volt-amperes, and lag angle, is clearly shown in the right angled triangle, Fig. 33.

As the lag angle becomes zero, the cosine of this angle, which is the power factor becomes unity, and the reactive volt amperes become zero, and the volt-amperes become equal to the watts.

40. Further Routine

We will proceed to develop some more detail, in regard to the routine technique of using vectors, by way of some concrete examples which will be taken up under various headings. The routine in each case will be stated arbitrarily, and then checked up by argument later.

41. Direction of a Voltage Difference Vector

A vector quantity in general, whether it has to do with electricity or stresses in bridges, is defined as a quantity having direction and magnitude.

In Fig. 14, the voltage difference vector, lettered "a" at one end and "b" at the other, completely represents the variations of voltage difference between the terminals "a" and "b" Fig. 13.

As the vector rotates and its "a" end is higher up than its "b" end, then the space terminal "a" is more plus than "b".

We have not used any arrow to indicate towards which end the vector is pointing, and in general we will not use arrows on voltage differences but, in some cases we will require to

know which way the voltage difference vector is pointing.

STATEMENT—We may call the vector Fig 14 "(a−b)" or we may call it "(b−a)". If we call it (a−b) then the following two conditions are implied :—

No. 1—"a" is the point end of the vector.

No. 2—The space diagram arrow must point towards "b" from "a", or "b" is the space arrow point.

Had we called the vector "(b−a)", then the reverse of No. 1 and No. 2 would have been implied :—

We may call the ROUTINE IN BRIEF —

(1) Voltage Vector, "(a−b)"

(2) Vector point, "a".

(3) Space Arrow Point "b".

If anyone of the three is given, then the other two must be made to agree.

Note that the arrows in the time and space diagrams point toward opposite letters as in (2) and (3), and that the naming of the vector, as in (1) must be written with the vector point letter first.

Argument has been advanced as to which of two voltages differences leads the other, as for instance in the case of the a to b voltage and the b to c voltage in a three phase supply.

The answer is indeterminate until the positive direction arrows have been assigned to the two pairs of terminals, a, b, and b,c,. The verdict as to which difference leads depends upon the arbitrary placing of these positive direction arrows. If the space arrows are placed towards b from a, and towards b from c, then the two vectors are (a−b) and (c−b), and the vector (c−b) leads (a−b) by 60 degrees.

If however the space arrows are placed towards b from a, and toward c from b, then the vectors are (a−b) and (b−c), and the vector (a−b) leads the vector (b−c) by 120 degrees.

This second placing of arrows has been upheld as the only correct placing because the sum of the three voltage differences, taken always in the same direction around a triangle, must add up to zero. In this case we would have the three vectors (a−b), plus (b−c), plus (c−a) equal to zero, which it is.

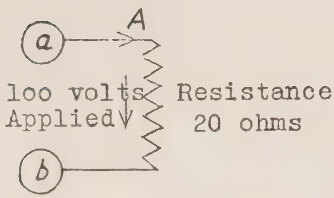
Should we however reverse one of the arrows we would still have a correct addition to zero because the reversed vector would have a minus sign before it, and the equation would be (a−b), minus (c−b), plus (c−a) is equal to zero.

Either placing of arrows is correct but when studying three phase apparatus which is symmetrical in regard to the three phases, the results work out more symmetrically if we start with the symmetrical placing of the arrows. On the other hand when studying polyphase metering connections the results are more symmetrical if we take the two vectors as (a−b) and (c−b).

CHECK ON THE ROUTINE :—The vector is called "(a−b)". Its vertical projection Fig. 14 is then $h_a - h_b$) which is plus because "a" is higher up than "b" and h_a is greater than h_b. Since the projection is plus, then the instantaneous voltage difference is plus and the vector is sloping upwards towards its point. The point then is the higher up end which is "a".

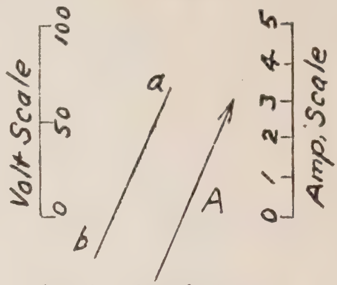
We are going to use the term "voltage urge" which will mean the tendency to flow due to voltage difference.

FIG. 34
SPACE



Ohmic Resistance

FIG. 35
TIME



Ohmic Resistance

The direction of voltage urge will be from any terminal towards another terminal which is less plus at the instant.

Again:— As "a" is higher up than "b" Fig. 14, then, "a" in Fig. 13 is more plus than "b", and the instantaneous voltage urge is from "a" towards "b". The instantaneous voltage difference is, however, plus because the vector is sloping up. Hence the plus direction is from "a" towards "b", and "b" is the point of the space arrow, as stated.

42. An Ohmic Resistance Across a Voltage

Fig. 34 shows the space diagram of an ohmic resistance of 20 ohms acted upon by a voltage of 100 volts. The figure has marked upon it the naming of its terminals, "a" and "b". An arbitrary positive direction of current flow, or of voltage urge, is marked by the arrow.

We wish to draw to scale, the time vector diagram of the voltage and current conditions present. We will use a routine which will be given below. and then check up on the correctness of the routine.

Routine—

No. 1. Lay off a suitable r.m.s. voltage scale, and a suitable r.m.s. amperage scale as shown Fig. 35.

No. 2. Draw the applied voltage vector in any direction, and make it 100 volts long by the voltage scale, and mark either end "a" and the opposite end "b".

No. 3. As the space arrow Fig. 34 points to "b" then the vector is named (a—b) and the vector point is "a", (not shown).

No. 4. Draw the current vector A parallel to (a—b) and make it 100/20 or 5 amperes long by the ampere scale.

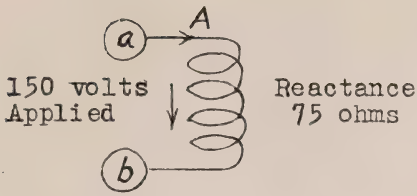
No. 5. Since the resistance is ohmic place the current vector arrow to point with the first term of the expression "(a—b)" which is "a".

Note that the current vector arrow point, as well as the voltage vector arrow point, is determined by the opposite letter in the space diagram from the one that determines the space arrow point.

Check of routine No. 3. See general heading No. 41.

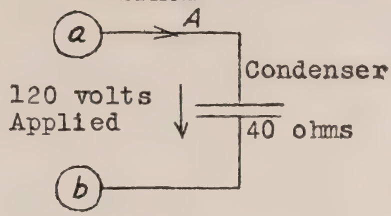
No. 4 and No. 5 as the current in an ohmic resistance is in step with the

FIG. 36
SPACE



Pure Reactance

FIG. 38
SPACE



Pure Condenser

voltage difference (or drop) on the resistance, then the vectors of amperes and volts must be parallel and pointing the same way.

43. Pure Reactance across a Voltage

Fig. 36 shows a reactance of 75 ohms value, fed from a voltage of 150 volts. This reactance is supposed to contain no ohmic resistance and hence is called a pure reactance.

To plot the voltage and current vectors as per Fig. 37 use the following routine:—

Routine

No. 1. Lay off scales as before.

No. 2. Draw the voltage vector 150 volts long and mark its ends "a" and "b" as before.

No. 3. "a" is the point of the voltage vector as before (not shown).

No. 4. Draw the current vector at right angles to (a—b) and make it 150/75 or 2 amperes long.

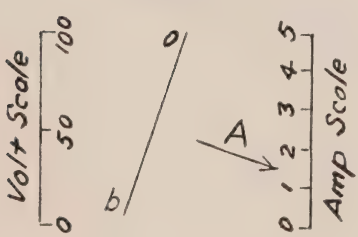
No. 5. Since the current in a pure reactance lags the voltage by 90 degrees, place the arrow on the end of the current vector which lags "a" by 90 degrees.

Checks on Routine. See heading No. 42.

44. A Pure Condenser Across a Voltage

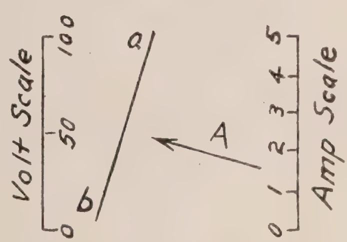
Fig. 38 shows a condenser of 40 ohms value, fed from a voltage of 120 volts.

FIG. 37
SPACE



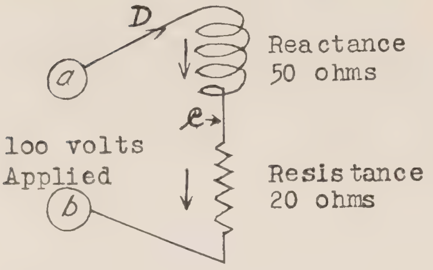
Pure Reactance

FIG. 39
TIME



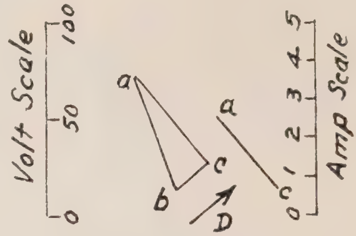
Pure Condenser

FIG. 40
SPACE



Resistance & Reactance

FIG. 41
TIME
Trial Diagram



Resistance & Reactance

ROUTINE

No. 1. As before.

No. 2. Voltage vector 120 volts long.

No. 3. As before.

No. 4. Draw the current vector at right angles to (a—b), 120/40 or 3 amperes long.

No. 5. Since the current in a pure condenser leads the voltage by 90 degrees, place the arrow on the end of the current vector which leads "a" by 90 degrees.

45. REACTANCE AND RESISTANCE IN SERIES

No coil or circuit has zero resistance, but a coil having resistance and reactance will behave the same as a suitable resistance and pure reactance connected in series.

Fig. 40 shows the space data of a 50 ohm pure reactance in series with a 20 ohm resistance across a voltage of 100 volts.

The solution of this network, or the plotting of its complete vector diagram to scale may (as in many other problems) be made simple or difficult, depending upon how we attack it. The best way to start a problem is dictated only by experience.

We will start this one by plotting an unknown quantity, and give it an arbitrary value, then after a tentative diagram is built up, we can learn facts that will make the complete plotting to scale, an easy matter.

Fig. 41 will be the tentative time diagram. We will start by plotting an ampere vector in any direction, and make it say one ampere long, and call it the current D, and place an arrow on one end of it.

The voltage upon the resistance alone is called the I R drop and its value is, the current times the resistance, or 1X20 or 20 volts, on the assumption of D being one ampere. The vector of this voltage would then be a line 20 volts long and parallel to D. The letters at the ends would be "c" and "b". We must find which letter belongs towards the point of D.

Using the "Routine in brief" given under heading 41 we see that in Fig.40 the tail of the space arrow at the resistance is "c". This letter then is the vector point, which points with D. Place then the letters "c" and "b" as shown in Fig. 41.

The drop in the reactance X is called the IX drop and its value is one ampere times 50 ohms, or 50 volts.

FIG. 42
TIME

Final Diagram
Reactance &
Resistance
(a-b) = 100. volts
(a-c) = 93. "
(c-b) = 37.2 "
Amps = 1.86
Lag = 68.2 degrees
Watts = 69.3
Velt-Amps = 186.
RVA = 173.
Total Impedance
=53.8 ohms

We are going to plot this drop as a vector by itself, and then place the letters "a" and "c" on it, and then move it to position with the "c" end coinciding with the "c" already plotted.

Draw an isolated line at right angles to D for the tentative IX vector. Its letters will be "a" and "c". The "a" is the tail of the space arrow at the reactance, hence the "a" is the point of the IX drop.

Since the current in a pure reactance lags its voltage by 90 degrees, then the voltage leads the current D by 90 degrees and the point "a" of the IX drop must lead the point of D by 90 degrees. Place the "a" and "c" on the detached vector as shown, then move this vector bodily to its place with the "c" upon the "c" end of (c—b).

The distance (a—c) must now be the IX drop which is one ampere times 50 ohms, or 50 volts. This determines "a". Now join a to b which is the tentative vector (a—b). This measures to be 53.8 volts long. The whole diagram must now be increased in size by multiplying every vector by 100/53.8 or 1.86. Fig. 42 shows that the true IR drop is then 20X1.86 or 37.2 volts. The IX drop is 50 X 1.86 or 93.0 volts. The current D is 1 X 1.86 equals 1.86 amperes. The angle of lag is the angle whose tangent is 50/20, or the angle is 68.2 degrees.

The watts are (a—b) times D times cosine of 68.2 degrees, which is 100 volts times 1.86 amperes times 0.372 or 69.3 watts. The volt-amperes are 1.86 times 100 equal 186 volt-amperes. The reactive volt-amperes are 100 volts times 1.86 amperes times sine of 68.2 degrees, or 100 times 1.86 times 0.93, or 173 reactive volt-amperes. The total impedance is 100/1.86 or 53.8 ohms.

Note that the quantity I^2R is 1.86 amperes times 1.86 amperes times 20 ohms, or 69.3 watts which is the same as the total watts. Since the current and votage in the reactance are 90 degrees apart, there is no energy expended there, and the total input watts is the same as the ohmic loss I^2R.

Note that the quantity I^2X is 1.86 times 1.86 times 50, or 173 volt-amperes which is the same as the reactive volt-amperes.

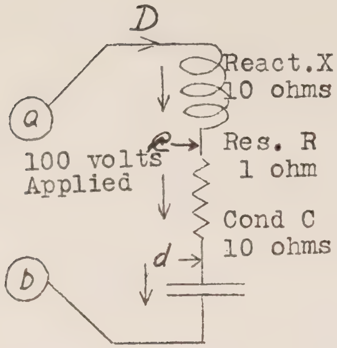
If a wattmeter and a reactive volt-ampere meter were applied to this or any other ohmic and reactive network then the wattmerer would read the total of all the I^2R losses, and the reactive meter would read the total of all the I^2X losses.

The difference in readings between two reactive meters, one on each side of a set of reactance coils should check with the total of the I^2X losses in the set of reactors.

46. Series Resonance

Fig. 43 shows a 10 ohm reactance, a one ohm resistance, and a 10 ohm

FIG. 43
SPACE



Series Resonance.

condenser, in series across 100 volts. The fact that the reactance and the condenser are of the same value as expressed in ohms impedance, means that the system is in resonance.

We will start as before, by assuming a trial value for the unknown current D, and call it one ampere as shown Fig. 44.

Our trial vector diagram will have

FIG. 44

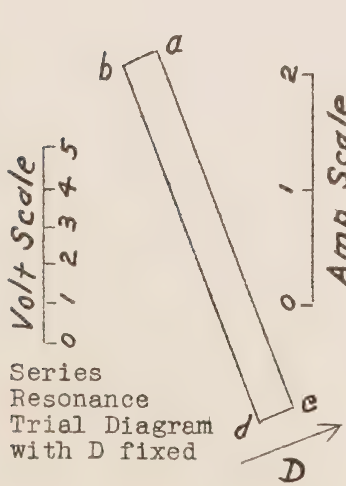


FIG. 45
TIME

Series Resonance
(Not Plotted)

Applied Volts, 100.
Reactance " ,1000.
Resistance " , 100.
Condenser " ,1000.
Amperes " , 100.
Total Impedance 1.

a reactance drop (a—c) of one ampere times ten ohms, or 10 volts. This drop will lead the current D by 90 degrees. The ohmic drop (c—d) is one volt, in step with D. The condenser drop (d—b) is 10 volts lagging D by 90 degrees.

The terminal volts (a—b) would then measure on Fig. 44 to be one volt.

Now as the true value of (a—b) is 100 volts, we must mutiply all vectors by 100/1 or 100.

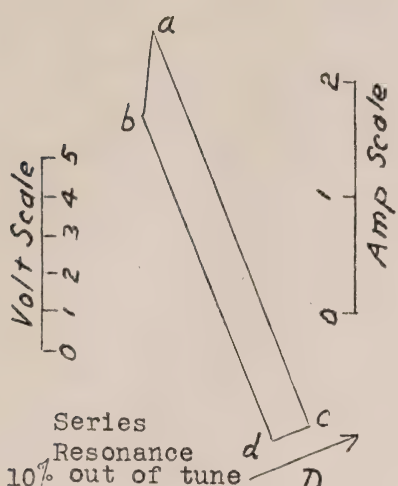
Fig. 45 gives the data of the full sized diagram (which has not been drawn).

The actual current is then 100 amperes.

Note that while only 100 volts are applied, yet there are voltages of 1000 volts upon the condenser and upon the choke coil. Note that the smaller the resistance value can be made in regard to the reactance then the larger is the resonance voltage amplification.

The values of the reactance and condenser expressed in ohms depend upon the freqency. As the frequency increases, the condenser ohms decrease and the reactance ohms increase. This decreases the IC drop (d—b) and increases the IX drop (a—c).

FIG. 46
TIME



Series
Resonance
10% out of tune
Trial Diagram
with D fixed

Fig. 46 shows the tentative diagram for one ampere current D and for a frequency 10 per cent. higher than that used in Fig. 44. Here (c—d) is the same as before, being one volt. (a—c) has become 11 volts instead of 10, and (d—b) has become 9.09 volts. (a—b) has then become 2.16, and the multiplier instead of being 100 is only 100/2.16 or 46.3. The actual values of voltage then are:

The applied volts (a—b) are 100.

The reactance volts (a—c) are 510 instead of 1000.

The condenser volts (d—b) are 420 instead of 1000.

The ohmic volts (c—d) are 46.3.

The amperage is 46.3.

The impedance is 2.16 ohms instead of one ohm.

Note that for resonance, as shown Fig. 44 and 45 the total impedance, and the current which flows is the same as though the condenser and reactance were each of zero value, while the IC volts are the product of this large current and the value of the condenser in ohms.

A pure reactance in series with a pure condenser of equal values in ohms have an impedance of zero and the voltage amplifying factor would be infinity.

It is only the unavoidable presence of ohmic resistance that limits the amplifying factor in the above case.

(*Continued in July Number*)

Luncheon to J. C. Martin

An Informal Luncheon held in the the Arcadian Court on June 13th was tendered Mr. J. C. Martin of the Station Section of the Electrical Engineering Dept. who has resigned from the staff to take a position with the Ford Motor Co. at East Windsor. "Joe" has been with the Commission almost thirteen years and during that time made for himself many good friends, he being a congenial helpful colleague to work with.

About fifty of his associates were present including representatives from the Stenographic, Construction and Operating Departments. A number expressed our general regret of "Joe" leaving and extended to him hearty good wishes of continued success in his new work. Mr. Martin was then presented with two silver entree dishes and a comport as a token of the esteem in which he was held. "Joe" fittingly expressed his appreciaton of the gift.

Modern Tendencies in Illumination

By Walter Cary, President, Westinghouse Lamp Co.

PRIOR to the coming of the electric incandescent lamp, much thought was given to lights, but none whatever was given to lighting. Lights of some sort were the daily concern of everyone, but the illumination they gave was merely taken for granted. The fixture —lamp, candlestick, or chandelier— was quite as important as the light because it was responsible for the proper burning of the light. But its utility was also taken for granted. It was regarded as an article of household furniture or a medium for interior decoration, and its value depended chiefly on its artistic merit. Light was, of course, a necessity, but since all of the early illuminants were expensive, troublesome and dangerous, there was a natural tendency to keep the number in actual use down to the very minimum.

The invention of the incandescent lamp brought into being a new kind of light. It was safe; it needed no care or attention whatever; it required no fixture except a simple socket; it could be supplied in a variety of sizes; and even in the early days its cost of operation was small. It was entirely different from the flame-bearing illuminants, and should have been accorded entirely different treatment; but the general public, though eager to adopt new things, finds great difficulty in adopting new lines of thought. The new lamp was accepted quickly and enthusiastically; but, being a light, it was treated just as other lights always have been treated.

This point of view still persists to a great extent, even after 50 years. The average person still thinks about lights rather than lighting, is still more interested in artistic fixtures than in illumination, and still feels that light should be used as sparingly as possible.

The illumination engineer, on the other hand, has known for years that illumination is the vital thing and that the illuminant is important only insofar as it provides the amount and kind of illumination we want. Casting aside all previous thinking in regard to lights, he has gotten down to fundamentals. How much illumination do we need ? What are the requirements of the human eye for reading, for working at different tasks, for gatherings of various kinds, for walking along a street, for driving, for landing airplanes ?

That this is the proper approach to this subject is self-evident. It needs no argument, no defense. And yet so strong is the tyranny of ancient ideas that popular acceptance of it has come slowly.

However, it is coming; and one of the most important tendencies in the illumination field today is the gradual abandonment of the medieval attitude in regard to light.

Seven Times More Light

Careful estimates of the needs of the human eye in all fields of activity indicate that, by and large, we need at least seven times as much artificial light as we are now getting. Our

eyes were, of course, created for daylight conditions, and though they are marvelously adaptable, they give us the best service, with least wear and tear, with comparatively high lighting intensities, provided glare is absent. One feels delightfully at ease in a properly lighted room. While it will undoubtedly be a long time before each office, factory, store, theatre, public building, and home is lighted with seven times as much light as it is now getting, the tendency is certainly in that direction.

To use these higher intensities, however, involves a revolutionary change in our lighting practice. No such amount of light can be furnished with the ordinary fixtures of today because the glare would be intolerable. Indoors, lamps for illumination must be concealed and the lighting systems must be designed for and be built directly into the building which it is to illuminate. Outdoors, we must abandon the use of exposed lamps and enclose them in prisms or lenses which place the light just where it is wanted, and prevent it from being wasted in the empty air or shining where it would do harm.

In a word, we are breaking completely with the past. Instead of continuing to extend the ancient art of lighting, we are creating an entirely new art.

Automatic Control of Lighting

Another well-marked tendency in this field is to remove from fallible human direction the control of our illumination. No factory, school, hall, or office should ever lack the amount of light actually needed at any time. At present, some one usually turns on the lights when he or she thinks it has grown too dark; but it may have been too dark long before that for some worker or student. We accept such conditions and automatically increase the strain on our eyes and bodies to compensate for them because we have always been accustomed to do so; but that is no justification for their continuance.

The modern method is to determine a minimum illumination level for the darkest spot in a given room. When, because of clouds, fog, or nightfall, the illumination on that spot falls below that level, an automatic light-sensitive device switches on sufficient light to add the right amount of illumination. If the daylight continues to fade, more lights are switched on, so that the whole room is properly illuminated at all times regardless of changing conditions.

Color

Another change that will probably take place is the increasing use of color in lighting. At present colored light is employed for decoration, signalling, and some other purposes, but ordinarily we use white light. It is, however, reasonable to suppose—and experience, notably with bluish-white light for detecting linen stains, and reddish light for brass and copper working, bears this out—that light of certain colors is more suitable than white for certain operations. Little has been done in this field simply because our color-range has until recently been very limited; but we now have a wide variety of tints and colors at our disposal, and are free to carry on any investigations that seem

desirable in this field which may result in much improvement.

Dividends from Lighting

Another forward step in illumination progress is the growing realization that it is false economy to create expensive structures and then forfeit a large part of their utility by leaving them unlighted at night. Proper illumination will care for this.

Architecture furnishes a case in point. Why should a beautiful building, monument, or statue be visible only during the daytime ? There is, of course, but one answer to this question. Probably all important buildings and outdoor works of art from now on will be designed with provision for proper external lighting.

Athletics provide another case. Until recently, almost all outdoor sports were purely daytime affairs; but now tennis courts, swimming pools, skating rinks, race tracks, football fields, and even baseball diamonds are being illuminated and used at night. Not only are millions of workers, who were previously debarred from these sports now able to enjoy them, but huge investments in athletic grounds are bearing double and triple returns.

Highway Lighting Awaits State Legislation

Most important of all, however, are our highways. An adequate lighting system increases the cost of a concrete highway by about five per cent., but increases its usefulness from 30 to 50 per cent., besides adding the immense advantage of enhanced safety, and reducing the cost, in many instances, by eliminating the necessity of extra width. The desirability of highway lighting is, therefore, undeniable.

But here again we encounter old ideas. In the view of our governmental bodies, a lighting system is not an integral part of a highway; it is an addition to it, like an ornamental fence or a series of decorative flower beds. If any county, township, or town wishes to add lights to that part of a state highway which runs through it, it is welcome to do so, but the state will not. Consequently, if the Lincoln Highway were to be illuminated, not only would thousands of communities have to act in concert, but they would have to spend large sums chiefly for the benefit of travellers who do not share in the expense. Highway lighting must, therefore, wait until the states pass legislation placing it in the same class as drains, culverts, and other essential parts of a highway's structure. Let us hope that time is not far off.

Good Street Lighting at $2.50 Per Capita

Street lighting, having gained governmental acceptance, is in a more fortunate position; but too often, its standards are still those of the oil and gas lamp days. If there is a light on each corner and one in the middle of each block, there is a street lighting system—and the fact that the illumination thus provided may be utterly insufficient for the public's use of the streets is not even considered.

But the present tendency is definitely toward improvement. Several cities—St. Louis, for example—have recently installed lighting systems laid out by illuminating engineers, and the results, in the form of decreases in accidents, crimes, and

traffic congestion and increases in business activities, safety, and security, are so striking that others are following their lead.

It is noteworthy that the total cost of the St. Louis installation is $2.50 per capita per annum, whereas the average cost of street lighting for the country as a whole is $1.05; hence, but a small increase in our expenditures for this purpose is needed to provide our cities with good lighting.

Airport Lighting

The necessity for lighting airports and airways has already been recognized; for without lighting, night flying is impossible; and without night flying, aviation cannot become commercially successful. Like aviation, this branch of illumination engineering is developing rapidly and it is difficult to say what it will be like five years from now.

Higher intensities of ground illumination, the automatic lighting of the landing lamps of minor ports on the approach of a plane, and the automatic lighting of obstacle, boundary, and other lights whenever daylight fails, are among the immediate certainties; but the great desideratum—the fog - piercing seachlight—still eludes us. We are, however, still searching hopefully for some form of radiation that will provide a solution of the problem.

The Windowless Building

Not the least interesting of recent developments in the illumination field is the windowless building. The great auditorium at Atlantic City—the largest room in the world—is an example. It has neither windows nor sky-lights, but so well is it lighted by searchlights concealed in the arched ceiling and ventilated by electrically-operated blowers, that in all probability few visitors have noted this fact.

It is not part of the programme of illuminating engineering to develop a windowless civilization, for even if windows are not required for light and air, they do supply a human need in the form of an outlook on the outer world; but they are no longer architectural necessities, and can be suppressed wherever it is desirable to do so. Where they are lacking, the illuminating engineer can provide very good substitutes with the help of dummy window panes, painted vistas, and daylight lamps.

Aesthetic Lighting

Though light has been used for decoration for a long time, its artistic possibilities are just beginning to be realized. A high authority has stated recently that the most important development in the lighting field during the next few years will be along aesthetic lines. "We have passed through the utilitarian stage," he states, "and we are now going to use light to increase the joy of living".

At all events, we are creating a new art—"painting with light". We can take a perfectly plain room and, in an instant, cover its walls and ceilings with exquisite designs and gorgeous, ever-changing colors; we can transform a sky-scraper into a living flame; we can make waterfalls, caverns, and chasms glow with indescribable beauty.

The outstanding example of aesthetic lighting was to be seen at the International Exhibit at Barcelona, Spain, last summer, where the largest

and most elaborate mobile-color lighting equipment ever built was installed. This exhibition was laid out on a hillside, and its main avenue ran from top to botton like a gigantic staircase a half a mile long. The chief feature of the lighting consisted of waves of color which ran down this sraircase, while cascades, fountains, the floodlights on buildings, and special electroliers changed their colors in harmony or contrast.

This installation will undoubtedly stimulate gala and decorative lighting of all kinds. Centrally controlled mobile lighting is especially suitable for parks, civic centres, etc., and it has even been suggested that the floodlighting of the buildings of entire cities may be co-ordinated in this manner.

Especially in view of the fact that light for illumination will to an even greater extent come from concealed sources, we can look forward to an increasing use of exposed lights and fixtures for decorative purposes. With this equipment freed from the necessity of being useful, the artist will be untramelled in his work and can devote himself to producing objects of pure beauty.

Ultra-Violet Light

Light does not have to be visible to come within the purview of the illumination engineer. Recently, in co-operation with the research scientist, he has begun to open up a new field—that of invisible ultra-violet light.

The discovery of the relation of this form of radiation to human health was one of the most striking and important of the present century. Ultra-violet light has the peculiar property of toning up the human system and making it resistant to colds, that it is a cure for rickets and of value in treating certain other diseases. It also has certain remarkable germicidal and chemical powers; and we also suspect that it will prove useful in many other ways.

Several different types of ultra-violet lamps have been developed for curative purposes. These will probably be gradually simplified, and some form of ultra-violet ray radiator may become a regular part of our household, office, and industrial equipment. Ultra-violet lamps are also being used for sterilizing water, sorting ores, testing diamonds, detecting counterfeit money and fraudulent paintings, and for various technological purposes; but, in general, the ultra-violet field is unexplored territory. We can be confident, however, that much more is going to be known about it within the next few years and developments will come utilizing it.

The Electric Eye

The photo-electric cell, or "electric eye", is the gateway into another, and very different, field for the application of light. This device has the peculiar property of giving rise to an electric current whenever a beam of light falls on it. With an electric current, any kind of apparatus can be controlled, and since the electric eye can be designed to respond to any color or intensity of light, the possibilities it presents are literally infinite. It has already been used to control automatic machinery in a large number of manufacturing processes, to detect fires, to count people and cars,

to control traffic, to sort cigars, fruit, etc., by color, to detect flaws in metal sheets, to turn lights on at night and off at dawn, to protect property from burglars, to assist in chemical operations, and for many other purposes. It gives us, in fact, a new instrumentality that promises to be of almost as much importance as the electric lamp itself.

Illuminating engineering

In conclusion, perhaps the most important tendency in the illumination field is the growing realization of the importance of illumination engineering. A few years ago this branch of science was regarded as a narrow specialty, but now it is recognized as a fundamental for all modern activities, from housekeeping to flying; and, thanks to the facilities offered by our colleges and by the lighting institutes established by the lamp manufacturers, the number of its students is multiplying rapidly.

Light is one of the essentials of living; and the more we know about it, the better and fuller our lives become.—*The Electric Journal.*

When Sir William Preece (then Mr. Preece) brought over the first telephones from America, he gave a lecture at a meeting of the British Association held at Plymouth. For the purpose of illustration, a circuit from Exeter was led into the lecture hall at Plymouth and a telephone connected at each end of the circuit. Transmitters were, of course, unknown at that period, and the earphone was used both as a transmitter and a receiver; also a single-wire circuit was used, the result being that the inductive disturbances were deafening, and it was with the greatest difficulty that conversation of any kind could be carried on.

I had been put in charge of the lecture arrangements and had arranged a switch at each end of the circuit with Morse inkers to communicate instructions. At Exeter, Inspector Harris was in charge of the apparatus. The lecture, which created very great interest, in view of the novelty of the subject, was attended by Lord Kelvin (then Sir William Thomson). Mr. Preece having roused the attention of his audience, proceeded to practical illustrations: "I will now ask Sir William Thomson to speak on the telephone to Inspector Harris, who is stationed at Exeter". Having called up Harris with Morse, I asked him to switch over to the telephone and listen. Having also switched on the telephone, I handed the latter to Lord Kelvin. We all expected to hear some very learned utterances and listened breathlessly. After considerable hesitation, as if he could not make up his mind what to say, Lord Kelvin came out with "Hey diddle, diddle, the cat and the fiddle. . .follow that up". Placing the telephone to his ear, Lord Kelvin listened intently, and at last a broad smile broke over his face. "He says, 'the cow jumped over the moon' "; at that there was a roar of applause from the delighted audience, after which the lecture proceeded.

Next day I proceeded to Exeter, and on meeting Inspector Harris there I congratulated him on the success of his efforts; he was pleased to hear this and asked for details, which I gave him. "Well," he said, "when Sir William Thomson spoke

I could only hear a confused jumble of words, and I shouted back as loudly and distinctly as I could, 'I can't understand what you say, please repeat'; I never said a word about 'the cow jumping over the moon'!"

— *Electrical Review.*

Heating of Metals by Electricity

A NEW process is described for the heating of metals by electricity. This is done by making the metal to be treated the kathode in a bath of electrolyte, another metal plate in the bath being the anode of a d.c. supply. If now the voltage is gradually raised, a series of phenomena takes place which were first investigated by Fizeau in 1844 and since then by many others. Briefly what happens is as follows :

Take a suitable vessel of refractory material, place in the bottom a fairly large plate connected to (+) side; fill with dilute H_2SO_4; connect a bar of metal to (−) side of circuit and lower it slowly into the liquid to a depth of several centimeters. On slowly increasing the voltage the following phenomena will be observed :

1. As long as the e.m.f. does not exceed a certain voltage (generally a few dozen volts) all that occurs is the decomposition of the water, H_2 being freed at the kathode and O_2 at the anode.
2. On increasing the e.m.f. at a certain moment sparks will occur between metal bar and liquid with slight irregular boiling of the liquid in contact with the metal. The current fluctuates strongly and has a comparative high average value. This may be called the "unstable" period.
3. If the e.m.f. is raised further at a certain moment there is formed in the liquid a gaseous layer or sheath round the bar which sheath is luminous, clear and circumscribed, forming a distinct separation between the metal and liquid and which is traversed by the current. The current is now steady and relatively small. This is the "stable" period. The sheath consists of H_2 and the positive element of the salt if this is present in the electrolyte. With an acid solution there will be only H_2 present and the color of the sheath will be pale violet.

As a result of the action of nascent hydrogen on the metal (heated by the current) some de-oxidation and scaling of the metal occurs, but the electric current also removes instantaneously and in a measure mechanically all surface impurities, the surface of the metal being thoroughly cleaned.

The thickness of the gaseous layer and its stability increase with the e.m.f. as does also its resistance and so increasing the amount of heat generated.

By regulation of the applied voltage or to a certain degree also by changing the conductivity of the electrolyte, the metal may be heated to any desired temperature up to the melting point.

Summary of the Action

The action on the treated metal is the same as if it were heat-treated in a furnace in a reducing atmosphere.

By means of insulating screens the action can be localized and thus the current reduced to a minimum (about 300 watts per sq. c.m. with 200 volts). Through the presence of metal salts in the solution these metals can be deposited (plated or welded) on the metal of the kathode. Of importance for reliable results are :

1. Constancy of e.m.f.
2. Homogeneity of electrolyte.
3. Progressive heating from zero.

Applications

(a) Tempering or hardening in one treatment.

(b) Welding of the same or different metals.

(c) Forging.

Future Developments

Experiments have been made and are under way of absorbing the electrolyte in a porous insulating material such as asbestos, which is in contact with a metal disc or cup connected to the (+) pole of the supply. By wiping this over, the metal article to be treated and which is connected to the (−) pole, local heating and cleaning may be produced. Thus will heat be applied as is paint with a sponge or a brush, and the amount regulated by simple hand pressure.—*Electrical Review.*

Improving Driven Grounds

(*Extracts from address by Rolf Selquist, Electrical Engineer, Copperweld Steel Co. before New Orleans Convention of the International Association of Municipal Electricians.*)

WITH the earth practically unlimited in capacity and of zero resistance any conductor electrically connected to it, or grounded, will tend to have and maintain the same potential as the earth; the only limitation being the electrical connection to the earth. While it is possible to reduce the resistance of the electrical connection to almost any desired value, economic considerations usually set up a limitation beyond which it is inadvisable to go. This point depends on the character of the circuit, apparatus, or hazards involved. For example, a heavy expenditure for an earth connection with a fraction of an ohm resistance at a sub-station or a generating station is justified by the value of the equipment which the ground protects. On the other hand, heavy expenditures for grounding signal boxes or isolated arresters, can not be economically justified. A ground of higher resistance will meet the electrical requirement and the cost will be considerably less. For such installations, a resistance of 15 ohms may be permissible, which often can be obtained with a single driven ground.

Many Tests

A large number of tests and investigations have been and are now

being made on driven grounds. One of the main purposes of these investigations is to determine the relation between the physical characteristics of driven grounds and their electrical properties. The results have been very much in agreement and have given us definite information. It is now known that the conductivity of the soil, as determined by its ingredients and moisture content, is the important factor in determining the resistance of a ground connection. The diameter of the electrode as well as its contact area only slightly affects the resistance of the ground connection at a given location and condition. This is in contradiction to the earlier ideas on grounding when the contact area of an electrode was considered the important factor. We now know that the contact resistance between a driven ground and soil is negligible, and that large electrode area is in itself no reliable indication of the adequacy of the ground. The important effect of the soil within a five or six foot radius of the electrode can be easily demonstrated by driving several grounds. For example, a 5/8 in. by 8 ft. driven ground, when installed, may have a resistance of 30 ohms. If a second electrode is driven immediately adjacent to the first and connected in parallel, there is practically no reduction in resistance, although the contact area has been doubled; whereas, if the second rod is driven at a distance of 10 ft. from the first electrode, the resistance of the two in parallel may be reduced to approximately 18 ohms or about 40 per cent.

Length of Grounds

Every driven ground should be long enough to reach permanent moisture. They should not be less than 6 ft. in length, and a minimum of 8 ft. is preferable. Longer rods may be used at times, but in most places an 8 ft. length reaches permanent moisture and the use of a longer rod is not commensurable with improvements obtainable by other means. In a few locations, particularly station grounds longer rods than 10 ft. are often used; in many instances as long as 20 ft. Here, of course, there are exceptional amounts of power to be dissipated, and every available means is used to obtain the lowest resistance possible.

The diameter of a driven ground should be no greater than actually required for driving purposes. As previously mentioned, large diameters add but little to the electrical efficiency of the ground. When using solid rods, diameters of ½ to ¾ in. are usually adequate. Rarely is a ground rod required larger than ¾ in. even in very hard soils except, perhaps, where lengths in excess of 12 ft. are used. When using hollow pipe, diameters of ¾ in. and 1 in. are usually necessary for driving without bending or splicing. In some places pipes as large as 2 in. are being used.

Resistance

After installing a driven ground, or any ground in fact, there is only one way to determine the protective value and that is by measuring its resistance. Consequently, the resistance of every protective ground should be measured. This may be done with a voltmeter and ammeter or by means of a ground resistance measurement instrument, of which there are a number on the market. Exact determinations are not necessary, but it is important to

know whether the resistance is of the order of 15, 50 or 200 ohms.

Where a driven ground has a resistance in excess of the desirable maximum value there are several ways of improving this ground. The simplest and generally the most practical method is to drive another rod 6 ft. to 10 ft. away from the first rod and connect the two in parallel. This as stated, reduces the resistance of the ground approximately 40 per cent. Additional rods may be used and these will decrease the resistance almost in proportion to the number of rods used. Another method of improving a ground is by lowering the resistivity of the soil surrounding the rod. This can be accomplished by salt treatment of the soil, which in high resistance soils often results in reduction of 50 to 70 per cent. The disadvantage of salt treatment is that salt is dissolved and carried away by the water flowing through the soil. Consequently, the salt must be renewed periodically, in order that the soil may retain the desired conductivity. However, this method is very satisfactory where supervision and regular inspection of grounds is possible. Tests made during the last few years show that salt applications are beneficial for at least one or two years or longer. While the salt is partially carried away by water after a year or two there appears to be some permanent improvement, especially after the salt has been renewed several times.

Permanency

Ground rods should be installed as permanently as possible. This is especially important since a ground, after once installed, is generally accepted as adequate and maintenance is too often neglected. Therefore, it is imperative that it can be relied upon for electrical protection for almost an indefinite period. Only long life material of ample size and ruggedness to withstand the effects of corrosion and possible mechanical abuse should be used.

For a good ground the soil must contain moisture and electrolyte; the latter usually being a soluble salt of some kind. Moisture and salt are corrosive agents and it is necessary to consider their effect on the life of the electrode. A wide variation in the corrosive action of different soils is to be expected. However, in general, corrosion will be greatest in grounds which have the best electrical characteristics, since the latter indicates high moisture and salt content. Therefore, it is advisable to use metals which are the least liable to corrosion. Where iron or steel are used, allowance should be made for rusting and only heavy sections should be permitted. Copper is one of the best of the common metals to withstand corrosion, and although it is attacked by some soils the rate of corrosion is usually very much less than that of iron.

The electrical connection between the grounding wire and the driven ground should be permanent and made so that there is no danger of it developing a high resistance. A high resistance connection or an insecure contact may alone nullify the benefits of the grounding and create a hazard instead of a protection. With reference to this, Dr. C. S. Peters, in technologic paper No. 108 of the

U.S. Bureau of Standards, states: "Substantial construction is one of the first considerations in making ground connections and should never be sacrificed for expediency. Unless workmanship and materials are of the best, the protection afforded may be inadequate and unreliable. Ground connections should be inspected at intervals not exceeding a year. Even shorter intervals are preferable. In no case should inspection be omitted, for it is unsafe to leave a ground connection without attention."

Don't Use Iron Wire

Iron wire should never be used on a permanent installation. It is very apt to rust off completely or the rusting of the wire where it is clamped to the driven ground, may cause a high contact resistance. In a soldered iron wire connection, the soldering must be very carefully done or the wire is liable to be injured just above the connection. The soldering temperature oxidizes the galvanized coating and may even result in complete removal of the galvanizing.

There has no doubt been considerable money wasted in using electrodes of larger diameter than necessary. These large diameters while adding little to the electrical efficiency greatly increase costs since this varies approximately as the square of the diameter, and further, results in additional labour costs for installing. The big variation in costs is apparent when it is considered that the diameter may be anywhere from ½ in. to 2½ in. Then, too, where one man and a four pound hammer might install a ½ in. rod in six or eight minutes, it takes two to three men fully twice as long to drive a 2 in. pipe with a fourteen pound sledge. To get the most for the money invested, use diameters as small as meet the driving requirements. Two driven grounds of small diameters connected in parallel will cost less than a single large ground and will be far more efficient..—*Electric Light and Power.*

The Consumer's Sense of Humor

An article in the April number of the *N.E.L.A. Bulletin* carrying the above caption refers more particularly to interference to radio sets from consumers' household equipment. This article contains a letter which was the basis of its title, and which we are publishing purely on account of the humour contained in it. Proper names appearing in the original have been deleted for obvious reasons.

"Friend Joe:

"You may not know it, but I reside on the Northeast corner of Summer and Barret Streets, in a brick veneer house, comfortably mortgaged. The mortgage doesn't perturb me much, but a transformer on a pole south of my mortgage on Barret Street, causes me acute misery not to mention unspeakable anguish. The transformer, I am informed and believe, is the property and corporate holding of a benevolent institution doing business under the name and style of the -- Southern You-tell-me-one Company, of which you are the local Big Gun.

"What I am getting at is that last evening, when radio reception

all over town was remarkably clear and pellucid, the disturbance which erupted from my all-electric set sounded like the patter of spring rain on a red hot stove. The first selection on the Palm Olive Hour was like unto the Battle of the Marne, with effects. The effects were contributed, presumably, by the – – – Southern Interference Company, incorporated under the laws of — — —. The second number (introduced by Philipps Carlin, with staccato accompaniment) was a weird representation of Feeding Time in the Zoo. We distinctly heard the roar of the famished lions, the strident yelp of the hyenas and the sibilant hissing of the boa constrictors, all furnished presumably by the — — Static Disability Company, a corporation organized and persisting contrary to the statute in such case made and provided. The third number, I think, was Fun in the Foundry, with a stunning climax, representing the blowing up of the whole damn works, the falling of debris on tin roofs, the siren shrieks of the fire department and the agonized wails of dying foundrymen—all sound effects by the – – – Sputterin' Inferno Company, a conspiracy organized and operating on a frequency of 500,000 discontented kilowatts. At this point, we wrecked the radio, wrapped our ears in hot towels, and slunk to our couch like quarry slaves scourged to the dungeon.

"I think, Joe, your naughty little kilowatts are running around at night, wasting the kilowatt hours in ungodly revelry. They are badly trained; they think every night is Hallowe'en, and go helling around our block, necking and sparking, and making life miserable for staid householders. I know that kilowatts must have their fling but keep them in at nights and teach them some manners. I am a patient man, but if I ever find one of your kilowatts pedalling around my screen-grid on his little kilo-cycle, I'm going to grab him and shake the brat until the sparks fly. I never killed a watt, but another night of torture like last and the — — — Stentorian Dynamic Dissonance Company, a corporation disorganized and existing under the laws of Gehenna, will be holding kilowatt obsequies.

"Seriously, Joe, your Street light at the intersection of Summer and Barret Streets has been defunct for a couple of evenings. This coupled with the fact that our radio trouble occurs only at nightfall, leads me to think that the interference emanates either from the defective light or the transformer. I may be wrong, but have your serfs check it. All expense in connection with fixing the light and cleaning the carbon out of the transformer, you may put on my bill, and I will send you a check for it, drawn on the Merchants National and guaranteed by the Kingston Bank.

Statically yours,

– – – – –

A Contrast

The two accompanying views show what can be done toward removing an unsightly condition along a highway, caused by the injudicious placing of poles. The two pictures were taken at approximately the same location, showing the same curve of the road in the distance, being on Highway No. 2, immediately west of Belleville city limits in Belleville rural power district.

Fig. 1 shows conditions before the improvement was made. On the left are seen old poles of the Bell Telephone Company and of an old rural power line recently purchased by the Hydro-Electric Power Commission of Ontario. These poles were painted white by the Highway Department in order to increase their visibility. New poles of the Bell Telephone Company are seen along the ditch on this side. On the opposite side of the road are the poles of an abandoned telegraph line which are also painted white.

In Fig. 2 all of the old poles have been removed. The Bell Telephone Company line is shown on the left-hand side of the road, the circuits being in cable. New Hydro poles are seen on the opposite side, the lines being carried behind the trees on brackets. The arrangement permitted the reconstruction of both lines without trimming any trees.

This section of the Highway runs through one of the scenic parts of the province, which makes the neat and attractive appearance of the roadside the more desirable, as well as removing a dangerous condition, both as to the operation of the lines and the use of the roadway.

Fig. 1

Fig. 2

Hydro News Items

Central Ontario System

The municipality of Bowmanville voted on June 23rd, on the purchase of their distribution system and the execution of a cost contract with the Commission.

* * * *

A new schedule of rates has been recommended for use in the municipality of Madoc, which recently concluded a cost contract with this Commission.

* * * *

The Municipality of Stirling has practically concluded the installation of meters on all its customers. The village load has consequently decreased from about 250 to 215 horsepower, though additional consumers have been added in the interval.

* * * *

Niagara System

On Sunday, May 25th, the single-phase underground primary line serving Hon. H. C. Nixon in South Dumfries Twp. failed again in service. This has happened on several previous occasions, but we were unable to establish the fault. In this case, however, we were able to maintain test current long enough to locate the fault, which was found in a ground-hog's hole. One ground-hog was found lying across the cable and another dead near-by. It was evident that the cable was in the way of easy access to the hole, and apparently the ground-hogs had made attempts to remove the cable, as tooth marks were plainly seen on the sheath. The cable was in an air pocket where the fault developed, which would account for our difficulty in breaking it down to ground on previous occasions.

* * * *

The Town of Essex has obtained approval for the installation of 61–300 watt multiple ornamental street lights on Talbot Street, being Provincial Highway through the town. A pendant type of bracket has been chosen, which will be mounted on steel railway poles with approximately 100-foot spacings in the business section, and 200-foot in the semi-residential section at the two ends of the town.

* * * *

The Town of Amherstburg has obtained approval for the extension of their ornamental street lighting system on Sandwich and Aspley Streets by adding 47–300 watt fixtures. These will be mounted on street railway poles on each side of the street and spaced approximately 200 feet, the lights being staggard.

* * * *

Approximately twenty-five miles of rural line is now under construction

near Strathroy. The line makes service possible to a considerable rural area in which rural service has not previously been available. This line is a good example of the necessity for general co-operation in a large area before the first trunk line can be built to give service to any individual consumers.

* * * *

The Aylmer Public Utilities Commission have requested that the billing and the meter reading of their consumers, which consist of 587 Domestic, 126 Commercial, and 13 Power, be done by the Aylmer Rural Power District staff. The billing for waterworks will also be done by the Rural office.

* * * *

At the request of the Embro Hydro-Electric System the operation, meter reading, billing and collecting of the local system is being done by the Ingersoll Rural Power District staff from May 1st, 1930.

An Appreciation

The following letter to Mr. J. E. B. Phelps, Manager, Sarnia Hydro Electric System, was from a user in Sarnia Rural Power District. In acknowledging this letter Mr. Phelps advised as to where the credit was really due. As letters such as this are not received very often, the general inclination being to take high-grade service for granted, we are very pleased to reproduce it.

Sarnia, Ont., Canada,
Apr. 21st, 1930.

J. E. B. Phelps, Esq.,
Manager,
Sarnia Hydro Electric System,
Sarnia, Ont.

My dear Mr. Phelps :

I cannot refrain from dropping a word in your ear to congratulate you and your boys on the grade of service and the authentic service that you deliver to customers.

It happens that long before any of you were born I operated electric light stations myself and therefore know something of the difficulties. These things do not build themselves and do not keep themselves going—so that, when the service is practically continuous for two or three years those in the "know how" realize that somebody is looking after it and doing it damn well.

My observation of human nature is that the great majority of people take all these things for granted and kick like a steer when anything happens that inconveniences them, but say nothing about it when the results are above par.

If par means what I think it does the accomplishments of you and your boys are most decidedly above par.

Yours very truly,

(Sgd.) ARTHUR C. JOHNSTON.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Chairman C. A. Magrath's Letter of Submittal of the Twenty-second Annual Report

To His Honour The Honourable
William D. Ross,
Lieutenant-Governor of Ontario.

May It Please Your Honour :

The undersigned has the honour to present to your Honour the Twenty-second Annual Report of the Hydro-Electric Power Commission of Ontario for the fiscal year ending October 31, 1929.

This Report covers all of the Commission's activities and also embodies the financial statements for the calendar year 1929, of the municipal electric utilities operating in conjunction with the various systems of the Commission and supplying electrical service to the citizens of the Province.

Dealing, as it does, with a multiplicity of activities relating to several electrical systems obtaining power from thirty-two hydro-electrical plants operated by the Commission, supplemented by power purchased from other sources, and recording financial and other data relating to the individual local municipal electric utilities, the Annual Report presents a large amount of statistical information, much of which must, of necessity, be of a summary character.

The financial statements, the statistical data and the general information given, however, are so arranged and presented as to convey a comprehensive outlook on the features of the Commission's operations. Not only does the Report record the progress made during the past year, but it gives, in addition, certain cumulative results for the various periods during which operation has been maintained in the respective municipalities.

The constructional activities of the Commission during 1929 were featured by a number of outstanding developments and expansions. In the Niagara system the tenth generating unit was ordered for Queenston generating station and the final

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extension to the power house to accommodate this unit is well under way. The third and fourth banks of transformers and synchronous condensers were ordered for Toronto-Leaside transformer station. The 220,000-volt transmission line conveying power from the Gatineau river plants has given good service and the westerly half of the second circuit, constructed on separate towers, has been completed and placed in operation. A two-circuit 110,000-volt steel-tower line was constructed and placed in service from a point near Queenston to St. Thomas. This will reinforce the power supply and improve voltage conditions in the western section of the Niagara system. In the Georgian Bay system, the generating system at Trethewey Falls was placed in operation and two small generating stations at Bala in the district of Muskoka were purchased and improved.

In the newly-formed Eastern system, which is a consolidation of the former Central Ontario and Trent, St. Lawrence and Rideau systems, additions were made to the high-voltage network which serves the dual purpose of linking together the three former systems and of connecting the several divisions of the present system with new large sources of power received at Ottawa over the transmission lines from the Gatineau river plants. The physical interconnection of these three systems forms an extensive network which in point of area comprise—but not, of course, in population served or load carried—approaches that of the Niagara system.

In the Nipissing system, the new generating station at Elliott Chute was placed in operation. In the Thunder Bay system progress was made on the new development at Alexander on the Nipigon river. This will have an installed capacity of 54,000 horsepower and is being pushed ahead to completion. The development involves the construction of a large semi-hydraulic-fill dam, the first of this type constructed by the Commission. In the Patricia district the Commission has constructed a development at Ear Falls at the foot of Lac Seul on the English river. This has an installed capacity of 5,000 horsepower.

The operation of the systems in general has been characterized by expansion, many lines and power stations being placed in operation to serve new territory and to improve the service in areas already supplied, and the amount of power delivered greatly exceeding the load carried by the Commission in any previous year. The dry summer affected the stream flow and generating capacity of plants in many parts of the Province, necessitating special arrangements to carry

the load, but the Commission was able to meet all demands, partly through the transfer of surplus power on some systems to meet the needs of others. Apart from the difficulty presented by a rapid increase in load with unusually low stream flow, the operation of the systems has been carried on successfully and uneventfully, the Commission's plants functioning smoothly and without any major failures of equipment. All necessary inspection and repair work has been carried out to maintain these plants in efficient condition to meet future demands.

During the year the Commission has given further consideration to the problem of providing satisfactory electrical service to the municipalities and industrial organizations of northern Ontario, particularly in the mining districts of Sudbury and Red Lake. In the former area the Commission has acquired the majority stock and thus obtained control of the Wahnapitae Power Company which has a capital of $1,180,000. The properties include three hydro-electric generating stations with installed capacities aggregating 10,700 horsepower, and a network of transmission lines supplying service to Sudbury and several mines adjacent thereto. In the Patricia district the development already referred to, constructed by the Commission at Ear Falls, will serve the mining district of Red Lake. The ultimate capacity of the site is estimated to be 30,000 horsepower.

Cost of Electrical Service Furnished by the Commission

The function of the Commission is not only to use its best endeavours to provide for the people of Ontario, at cost, an adequate and reliable supply of electrical energy, but also to ensure that the cost of that electrical energy to the consumers shall be the minimum consistent with the financial stability of the enterprise. The success that has been attained in the accomplishment of the latter object may be appreciated by a careful study of the statistical data relating to the supply of electrical energy to consumers as given in Statement "D" and the actual rates to consumers as presented in Statement "E," in conjunction with the various financial statements of the Report.

Growth in Load

The following tabulation (Table No. 1) shows the growth in load in the various systems during the year.

Financial Summaries

It will be observed that the financial statements embodied in this Report are presented in two main divisions, namely, a division—Section IX— which deals chiefly with the operations of the Commission in the generation, transformation and transmission of electrical energy *to the co-operating municipalities*, and a division—Section X— which deals with the various operations of the municipal electric utilities in the localized distribution of electrical energy *to consumers*.

The cumulative results to date of the operation of the several systems of the Commission as set forth in this Report demonstrate a healthy financial condition.

The total investment of the Hydro-Electric Power Commission of Ontario

Table No. 1
Distribution of Power to Systems
20-Minute Peak Horsepower
System Coincident Peaks

System	October 1928	December 1928	October 1929	December 1929
Niagara system	879,337	894,772	949,732	970,509
Georgian Bay system	20,082	21,595	22,118	22,961
Eastern system	60,740	63,614	62,035	65,938
Ottawa system	20,241	21,213	22,079	23,050
Thunder Bay system	48,910	66,300	77,117	64,588
Nipissing system	3,170	3,248	3,599	3,492
Total	1,032,500	1,070,742	1,136,689	1,150,538

in power undertakings and hydro-electric railways is $222,082,637.06, and the investment of the municipalities in distributing systems and other assets is $92,154,280.86, making in power and hydro-electric railway undertakings a total investment of $314,236,917.92. The total revenue derived from the operation of these properties aggregated $39,969,624.83 in the fiscal year 1929.

Capital Investment

The following statement (Table No.2) shows the capital invested in the respective systems and municipal undertakings.

Combined Revenue

As usual the Commission is able to report that the revenue obtained from the consumers has been more than sufficient to meet the full cost of generating and transmitting the electrical energy as well as to provide for all operating expenses and fixed charges of the municipal utility equipments.

Table No. 2

Niagara system	$168,004,159.13
Georgian Bay system	6,310,034.95
Eastern system	18,045,388.36
Madawaska system	1,864,647.32
Ottawa system	537,194.40
Thunder Bay system	15,325,411.00
Northern districts	1,565,754.37
Hydro-electric railways	7,259,996.73
Office and service buildings, construction plant, inventories, etc	3,170,050.80
	$222,082,637.06
Municipalities' distributing systems and other assets (exclusive of $14,754,865.40 of municipal sinking fund equity in H.E.P.C. system)—all systems	92,154,280.86
	$314,236,917.92

The following statement (Table No. 3) shows the combined revenue of the Hydro-Electric Power Commission and the municipal electric utilities:

TABLE NO. 3

Revenue of the Hydro-Electric Power Commission:			
From the municipal electric utilities, rural power districts, hydro-electric railways and other power customers—			
Niagara system	$20,231,830.28		
Georgian Bay system	799,343.17		
Eastern system	2,561,774.89		
Ottawa system	243,777.52		
Thunder Bay system	1,454,080.66		
Bonnechere storage	4,144.31	$25,294,950.83	
From rural consumers:			
Niagara rural power districts	$1,432,978.27		
Niagara rural lines	3,889.67		
Georgian Bay rural power districts	74,225.78		
Georgian Bay rural lines	288.75		
Eastern rural power districts	150,323.11		
Ottawa rural power districts	26,928.28	1,688,633.86	
		$26,983,584.69	
From hydro-electric railways:			
Sandwich, Windsor and Amherstburg Ry.	$1,241,041.79		
Guelph Radial Railway	117,947.81	1,358,989.60	
Total revenue of the Commission			$28,342,574.29
Revenue collected by the municipal electric utilities			29,206,684.53
Aggregate revenue of the Commission and the municipal electric utilities			$57,549,258.82
**Deduct:*			
Revenue from power supplied to municipal electric utilities		$17,470,930.93	
Hydro-electric railways		108,703.06	17,579,633.99
Combined revenue			$39,969,624.83

*NOTE: This deduction is made due to the fact that the revenue of the municipal electric utilities is the source from which the Commission is reimbursed for the cost of power supplied to such utilities.

Revenue of Commission

The Commission collected from the municipal utilities and other customers, for power supplied, a total sum of $26,983,584.69. This sum was appropriated to meet all the necessary fixed charges and to provide for the expenses of operation and administration. After meeting all charges there was left a net surplus of $1,575,225.81.

The following statement (Table No 4) summarizes the Commission's collections from municipal electric utilities and other power customers for the year and shows how the collections have been appropriated :

Table No. 4

Revenue from municipal electric utilities and other power customers		$26,983,584.69
Appropriated as follows :		
Operation, maintenance, administration, interest and other current expenses	$18,048,129.36	
Reserves for sinking fund, renewal of plant and equipment and contingencies and obsolescence	7,360,229.52	25,408,358.88
Net surplus, after providing for all expenses and necessary fixed charges, credited to municipalities and shown in their accounts		$1,575,225.81

Rural Electrical Service

During the past few years very substantial progress has been made in Ontario in the field of rural electrification. Practically all rural electrical service is now given through rural power districts which are operated directly by the Commission. There is now more than $9,300,000 invested in the rural power district systems established by the Commission. Towards this rural work the Ontario Government, pursuant to its policy of promoting the basic industry of agriculture, has, in the form of grants-in-aid, contributed 50 per cent. of the costs of transmission lines and equipment, or about $4,600,000. About 4,835 miles of transmission lines have been constructed to date, of which 1,044 miles were constructed during the past year, a mileage which exceeds that constructed in any former year. There are now more than 37,000 customers supplied in the rural power districts.

Municipal Electric Utilities

The following (Table No. 6) is a summation of the year's operation of the local electric utilities conducted by municipalities receiving power under cost contracts with the Commission.

Reserves of Commission and Municipal Electric Utilities

The total reserves of the Commission and the municipal electric utilities for sinking fund, renewals, contingencies and insurance purposes amount to $89,940,323.61, made up as follows (Table No. 7):

TABLE NO. 5

RURAL POWER DISTRICTS—OPERATIONS FOR YEAR 1929

	Niagara system	Georgian Bay system	Eastern system	Ottawa system	Totals
	$ c.	$ c.	$ c.	$ c.	$ c.
Cost of power as provided to be paid under Power Commission Act........	500,499.08	27,535.78	56,970.68	7,316.27	592,321.81
Cost of operation, maintenance and administration.....	367,223.50	15,075.73	42,239.93	7,523.21	432,062.37
Interest............	156,259.41	9,601.45	15,943.78	3,988.34	185,792.98
Renewals............	137,071.36	7,566.59	13,205.79	3,114.38	160,958.12
Obsolescence and contingencies.........	68,535.68	7,566.59	4,247.96	1,557.19	81,907.42
Sinking fund........	36.330.90	2,221.80	3,470.08	862.62	42,885.40
Total expenses...	1,265,919.95	69,567.94	136,078.22	24,362.01	1,495,928.10
Revenue from customers............	1,432,978.27	74,225.78	150,323.11	26,928.28	1,684,455.44
Surplus.........	167,058.34	4,657.84	14,244.89	2,566.27	188,527.34
Net surplus......	....	....	....	....	188,527.34

The consolidated balance sheet of the municipal electric utilities, on page 255, shows a total cash balance of $858,733.68, and bonds and other investments of $2,001,088.81. The total surplus in the municipal books now amounts to $30,710,047.48, in addition to a depreciation reserve and sundry other reserves aggregating $13,348,525.75.

The following is a brief summary of the principal operations relating to the several systems of the Commission :

NIAGARA SYSTEM

The Niagara system embraces all the territory lying between Niagara Falls, Hamilton, and Toronto on the

TABLE NO. 6

Total revenue collected by the municipal electric utilities..		$29,206,684.53
Cost of power...........................	$16,379,162.88	
Operation, maintenance and administration .	5,116,401.73	
Debenture charges and interest............	3,839,897.13	
Depreciation...........................	1,469,846.83	
Total......................................		26,805,308.57
Surplus for the year, includes surplus from H.E.P.C.....		$2,401,375.96.

TABLE NO. 7

Niagara system	$35,940,823.40
Georgian Bay system	1,655,366.18
Easter system	3,447,043.82
Ottawa system	24,734.17
Thunder Bay system	1,566,520.54
Bonnechere storage	16,450.97
Service buildings and equipment	542,754.55
Hydro-electric railways	133,298.05
Insurance, workmen's compensation and staff pension insur'ce.	2,554,758.70
Total reserves of the commission	$45,881,750.38
Total reserves of municipal electric utilities	44,058,573.23
Total Commission and municipal reserves	$89,940,323.61

east, and Windsor, Sarnia, and Goderich on the west, served with electrical energy generated at plants on the Niagara river, supplemented with purchased power transmitted from the Gatineau river.

There has been a steady increase in the number of consumers in this district and also in the load supplied by the Commission to the municipalities. Because of this rapidly increasing load it was necessary to arrange with the Gatineau Power Company for power in excess of that which was to be delivered in 1929, as provided for in this Company's agreement with the Commission. Power supplied to the Commission by the Gatineau Power Company is received by the Commission at the interprovincial boundary on the Ottawa river and is transmitted over a 220,000-volt, steel-tower transmission line, to Leaside. The construction of the western half of a duplicate circuit, on separate steel towers, of this transmission line was completed during the year and put into operation to assist in carrying the heavy winter load.

A 110,000-volt, steel-tower transmission line from Niagara Falls to St. Thomas, which was planned during the previous year was completed and put into service to assist in taking care of the increasing demands in the western part of the area served by the Niagara system.

The installation of a tenth unit in the Queenston generating plant, which was arranged for in the previous year, is well under way, and the unit will be available to assist in taking care of the winter load for 1930-31.

The Commission in this system has a total capital investment of $168,004,159.13 and accumulated reserves for renewals, sinking fund and contingencies aggregate $35,940,823.40. In the rural power districts of this system, which are operated directly by the Commission, the revenue for the year from customers was $1,432,978.27, and the total cost of supplying the service was $1,265,919.93, leaving a balance of $167,058.34, which is placed to the credit of the districts in this system. The greater part of this surplus is returnable to the users in the form of reduced rates.

With respect to the electric utilities of the municipalities comprising this system, the actual cost of power during the year was $1,069,149.68 less

than the amounts of the interim bills. The municipal electric utilities operated with a net surplus of $1,756,-030.55, after providing $1,250,559,13 for depreciation and $1,511,788.75 for the retirement of instalment and sinking fund debentures. Seventeen municipalities had deficits during the year, aggregating $15,328.77. The total revenue of the municipal electric utilities in this system was $24,175,876.01, an increase of $2,000,-747.82.

Georgian Bay System

The Georgian Bay system serves that portion of the Province lying to the north of the area served by the Niagara system and west of the area served by the Eastern system. It comprises the territory adjacent to lake Huron and Georgian bay from Kincardine on the west to Uxbridge and Port Perry on the east, and north as far as Huntsville in the district of Muskoka.

Electrical energy is obtained from six hydro-electrical developments and from a frequency-changing station through which a block of power is obtained from the Niagara system. Surplus power is also obtained from a development owned by the town of Orillia. The combined capacity of these various sources of power all of which are tied together by a network of transmission lines approximates 25,000 horsepower. One of these developments, viz.: that at Trethewey Falls on the south branch of the Muskoka river with a turbine capacity of 2,300 horsepower was completed and placed in operation during the year. Arrangements were also completed for constructing an additional frequency changing station at Hanover, power being obtained for this station over a 110,000-volt transmission line between Kitchener and Hanover, part of which was erected during the year. It is expected that this station and line will be placed in operation during the summer of 1930, which will make available approximately 5,000 horsepower additional for the Georgian Bay system. Investigations and surveys concerning additional developments on the Musquash river at Ragged rapids were also carried on during the year in order to provide for additional plant capacity for the Georgian Bay system when required.

The results of the past year's operation were substantially better even than in 1928, which, up to that time, was the most successful year in the history of the system. The total capital invested by the Commission in this system is $6,310,034.95, and the accumulated reserves, inclusive of renewals, sinking fund, and contingencies aggregate $1,655,366.18. The revenue for the year from the rural power districts on this system which are directly operated by the Commission, amounted to $74,225.78, whereas the total cost of service was $69,567.94, thus leaving a balance of $4,657.84 to be placed to the credit of the system.

The results obtained during the year from the operation of the electrical utilities in the various municipalities have been most satisfactory. The total cost of power during the year was $77,630.81 less than the total amount collected at the interim rates. The total net surplus for the year from the various municipal

electrical utilities amounted to $104,025.71, after providing $51,784.00 for depreciation, and $53,389.04 for the retirement of installment and sinking fund debentures. Five small municipalities operated with an aggregate loss of $2,424.78, whereas the total combined surplus of the other municipalities comprising this system was $106,450.49, and the total revenue collected was $1,044,636.48.

Eastern System*

This system, as at present constituted, combines the three systems hitherto known as the Central Ontario and Trent, the St. Lawrence and the Rideau systems. Except for the relatively small areas served by the Ottawa system, and the newly acquired Madawaska system, referred to later, the Eastern system serves the entire eastern part of the Province, that is, the territory lying to the east of the county of Ontario and the district of Muskoka, and bounded on the north, east and south by the Ottawa and the St. Lawrence rivers and lake Ontario.

The combining of these systems was necessitated in order to obtain an ample supply of additional power for the present and future needs of the eastern part of the Province. The Eastern system shares with the Ottawa system the mutual benefits to be derived by the purchase, from a common source, of power in bulk for future expansion. Under a contract with the Gatineau Power Company the Commission obtains a supply of 60-cycle power up to 100,000 horsepower from large developments on the Gatineau river. The various divisions of the Eastern system are now linked together by high-voltage transmission lines. The power is received by the Commission near Ottawa and from this city a 110,000-volt transmission line extends to the town of Smiths Falls of the Rideau district. From there one line branches off south to Brockville connecting with the St. Lawrence division at its westerly end; and another line branches off south-west to Kingston, connecting with the Central Ontario division at its easterly end. In addition to the benefits derived by the purchase of power in bulk from a common source, and those resulting from the physical interconnection of transmission systems, the consolidation of the accounting and operating activities will also effect economies to the partner municipalities.

The Commission in this system has a total capital investment of $18,045,388.36 and accumulated reserves for renewals, sinking fund and contingencies aggregate $3,447,043.82. In the rural power districts of this system, which are operated directly by the Commission, the revenue for the year from customers was $150,323.11, and the total cost of supplying the service was $136,078.22, leaving a balance of $14,244.89, which is placed to the credit of the districts in this system. The greater part of this surplus is returnable to the users in the form of reduced rates.

With respect to the electric utilities of the municipalities comprising this system, the actual cost of power

*Note.—The formation of the Eastern system was not consummated until the earlier sections of this Report were in press. Consequently in Sections I to VI of this Report the former names of the eastern systems are used.

during the year was $68,263.05 less than the amount of the interim bills. The municipal electric utilities operated with a net surplus of $262,046.96, after providing $72,774.21 for depreciation and $79,272.11 for the retirement of installment and sinking fund debentures. Three municipalities had deficits during the year, aggregating $1,612.16. The total revenue of the municipal electric utilities in this system was $1,888,943.06.

Madawaska System

The Madawaska system is the latest acquisition of the Commission to serve eastern Ontario. The properties comprising this system were formerly owned and controlled by Mr. M. J. O'Brien and were acquired by the Commission in June, 1929. The properties include the Galetta Electric Light Company, which serves the town of Arnprior and several adjacent villages and hamlets from a development on the Mississippi river at Galetta, capacity 1,400 horsepower; and the Calabogie Power Company with a plant at Calabogie on the Madawaska river, capacity 6,000 horsepower, which serves the municipality of Renfrew and is interconnected with the Galetta plant. In the town of Renfrew, several industries are supplied direct with power, and service is also given to some small rural communities in the vicinity of Renfrew and at Calabogie.

For the present the properties are being operated by the Commission in a similar manner to that followed by Mr. O'Brien. The undeveloped water power sites on the Madawaska river have an aggregate potential magnitude of 150,000 horsepower. The properties purchased included four of these sites, with an estimated capacity of about 85,000 horsepower.

Ottawa System

The Ottawa system serves the city of Ottawa, the village of Richmond, and the Nepean rural power district. Both the Nepean rural power district and Richmond obtain their supply of power through the distribution system of the city of Ottawa, Richmond obtaining its power over the network of lines supplying the Nepean rural power district.

For many years Ottawa has been receiving power through the Hydro-Electric Power Commission from the plant of the Ottawa and Hull Power Company. This company, now a subsidiary of the Gatineau Power Company, is under contract to supply the Commission with 20,000 horsepower. Hitherto this power has been developed in the company's plant on the Quebec side of the Ottawa river, opposite Ottawa. The power supply of 20,000 horsepower is now all in use and additional power is being obtained by virtue of the contract made with the Gatineau Power Company for bulk supplies for the general use of eastern Ontario. Under special arrangement, the Gatineau Power Company, throughout the year, has delivered any power required in excess of the 20,000 horsepower over the same lines as are used to supply this power. This arrangement provides for the additional needs of the system pending the completion of the 110,000-volt transformer station in the vicinity of the western part of the city of Ottawa, where additional

power supply will be available from the Gatineau Power Company to meet future requirements.

Thunder Bay System

The Thunder Bay system serves the cities of Port Arthur and Fort William and the village of Nipigon situated in the district of Thunder Bay at the head of the Great lakes. Power is obtained from a hydro-electric development located at Cameron Falls on the Nipigon river, about seventy miles east of Port Arthur.

A second development on the Nipigon river, at Camp Alexander, has been undertaken by the Commission to supply the growing demands for electrical energy in the Thunder Bay district. Alexander development, the capacity of which will be 54,000 horsepower, is situated a short distance below the Cameron Falls development and will probably be completed and placed in operation during the fall of 1930.

Power in this district, apart from that utilized for ordinary domestic, commercial and municipal purposes, is supplied chiefly to pulp and paper mills and terminal grain elevators at Port Arthur and Fort William. The demand for power last year on this system was greater than during any previous year, a peak of 77,000 horsepower having been established during the month of September. Had the grain trade been normal, and had plant capacity been available the peak load, in all probability, might have reached the neighbourhood of 85,000 horsepower. The actual increase in this peak over that established the previous year was approximately 20,000 horsepower. The average power sold to Port Arthur during the year increased by 7,381 horsepower over the previous year. One of the large paper companies served increased its load by approximately 14,000 horsepower.

The Commission has, in the Thunder Bay system, a total investment of $15,325,411.00, and accumulated reserves for renewals, contingencies, and sinking fund aggregating $1,566,520.54. The total revenue of the municipal electrical utilities in the system was $1,484,139.12, being $127,545.33 greater than in 1928, and the total revenue collected by the Commission for power sold to the municipalities and private companies was $1,454,080.66, or $309,049.11 greater than for total collections from customers during 1928. The three municipalities served by this system operated with a net surplus of $210,338.06, after providing depreciation to the extent of $38,671.00 and $22,901.53 for the retirement of debentures all three showing substantial surpluses.

Nipissing System

This system serves the district adjacent to and inclusive of the city of North Bay, the town of Powassan, and the villages of Callander and Nipissing adjacent to the eastern end of lake Nipissing. Three hydro-electric developments now serve this system, all of which are situated at power sites on the South river namely, at Nipissing, Bingham Chute, and Elliott Chute. The last named plant, with a turbine capacity of 1,800 horsepower, was completed

and placed in operation during the year.

Wahnapitae District

The service given by the Wahnapitae Power Company, the majority stock of which was acquired by the Commission during the year, has been continued with the same operating staff. Certain improvements have been made to the hydraulic structures; and service to Sudbury and other power customers has been continued as usual. Investigations have been carried on with a view to obtaining, either by development or purchase, a large block of power for use by mining properties adjacent to Sudbury.

Patricia District

The hydro-electric development at Ear Falls at the foot of Lac Seul on the English river was completed during the year. This will supply power to mining developments in the Red Lake area. The Commission also co-operated with the Provincial authorities in the design of a conservation dam at Lac Seul, and of some marine railways to facilitate transportation between Lac Seul and Red Lake.

The Annual Report

The Table of Contents, pages xxi and xxii, conveys a good understanding of the scope of the matters dealt with in the Report, to which there is also a comprehensive Index. To those not conversant with the Commission's Reports the following notes will be useful.

In Section II, pages 5 to 51, dealing with the Operation of the Systems, are a number of interesting diagrams showing, graphically, the increase in the loads on the various systems. Tables are also presented showing the amounts of power taken by the various municipalities during the past three years.

The rural distribution work of the Commission has proved of widespread interest and special reference to this is made in Section III, on pages 61 to 75. The power distributed to rural districts is, and possibly must always be, but a relatively small proportion of the power distributed by the Commission. The supplying of electrical service in rural areas, and especially on the farm, has, however, been of great economic benefit to Ontario. The Provincial Government grants-in-aid to this work have been of value to agricultural activities, and have assisted the Commission to extend transmission lines to many areas.

In Sections IV, V and VI will be found information respecting progress of work on new power developments and on transmission system extensions, together with photographic illustrations.

About three-fifths of the Report is devoted to statistical, financial data, which are presented in two Sections, IX and X.

Section IX presents in summary form the financial statements relating to the operations of the Commission chiefly in the generation, transformation and transmission of electrical energy to the co-operating municipalities. It is introduced by an important explanatory statement which appears on pages 125 to 129, to which special reference should be made.

Section X presents in summary

form the financial statements relating to the operations of the municipalities in the localized distribution of electrical energy to consumers. It also contains details of the costs of electrical energy to consumers in the various municipalities and tabular statements of the rates in force which have produced these costs. An explanation of the various tables and statements is given at the commencement of this Section of pages 249-251; and a special introduction to Statement "D," which relates to the cost of electrical service in Ontario, together with a diagram, appears on pages 360 to 363.

In its Annual Reports the Commission aims to present a comprehensive statement respecting the activities of the whole undertaking under its administration. Explanatory statements descriptive of the operations of the Commission in various branches of its work are suitably placed throughout the Report in order that the citizens of the Province may be kept fully informed upon the working-out of the Commission's policies.

* * * *

The various statements in this report bear testimony to another year of fine progress. During the year, a large block of electrical power was contracted for from the Beauharnois Power Corporation. The policy of the Commission is to ensure ample supplies of power to meet the growing needs of the co-operating municipalities.

In the development of this Province with its vast natural resources there seems to be but one sound policy, and that is to have available ample power supplies. If there is one obligation particularly resting upon a publicly-owned organization in hydro-electric development, it is to keep well ahead of the demand. That problem was quite serious a few years ago, and for a while threatened the Commission with some embrarrasment. At that time the eastern part of the Province was quite exercised over the question of power supplies. That concern has since been removed, and the Commission has reason to believe that Ontario's Hydro municipalities are fully satisfied with the policy that has been pursued in order to take care of their electrical requirements.

The Commission has purchased power properties during the past twelve months on the Madawaska river, which enters the Ottawa river near Arnprior. Under full development, the Madawaska has a potentiality of about 150,000 horsepower, Similarly, a power property in the Sudbury district, known as the Wahnapitae Power Company, was acquired.

Beyond a few relatively small scattered properties, the only other sources of hydro-electric supply within the more closely settled portion of the Province, are in the waters of the Ottawa, St. Lawrence and Niagara rivers; all of which are either interprovincial or international, and in their development call for co-operation by interests outside of this Province. Involved in the international waters there are in Canada federal and provincial issues, calling for settlement. Moreover, there is a corresponding situation on the United States side of the St. Lawrence river

where the federal government of the United States and the authorities of the State of New York do not seem yet to have reached agreement with regard to their respective claims.

During the past year, the Commission has been negotiating with Quebec interests for developments at both the Carillon and Chats power sites on the Ottawa river, and it is hoped that, at an early date, arrangements for proceeding with the work at the Chats site will be brought to a satisfactory conclusion.

The various reports herein presented clearly show that the Commission, in addition to taking care of its sinking fund requirements, is working into a strong position through the setting aside of very substantial reserves.

It is a pleasure to me again to acknowledge the splendid services always given by all employees. The Commission has a fine technical organization, and it is so regarded by those who come into contact with its staff.

To those entrusted by the various municipalities with the direction of their local "Hydro" utilities, I wish to express the sincere thanks of my colleagues and myself for their whole-hearted co-operation, and to the Press of the Province I also wish to say that we are very grateful for its service and support.

Respectfully submitted,

CHARLES A. MAGRATH,
Chairman.

Load Unbalance on Single-phase Distribution Secondaries

By E. R. Lawler, Asst. Engineer, Municipal Engineering Dept., H. E. P. C. of Ontario

(Read before Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 7, 1930

AS long as some of us can remember secondary load unbalance has existed. No united action has been taken to correct it. Most systems spent considerable money on increased capacity, thereby lessening its effect on voltage regulation and proceeded to forget its existence.

Since the advent of low rates for service, consumers are requiring more substantial amounts of electrical energy from the distribution system. This has caused the making of a closer check on the distribution losses. A need is evident for more efficient distribution.

Better efficiency of primary distribution has been obtained by voltage practically double, and in a few cases four times that originally used. At the same time the feeders have been changed from single to polyphase.

On the secondary distribution, however, with few exceptions, the same 110–220-volt or 115–230 volt single-phase distribution is in general use. An exception is the two or three phase secondary network covering small areas of large cities where load density is great (25,000 kw. and greater per square mile).

Another exception in Ontario is the increase from 220 to 550 volts for motor voltage. This has resulted in great savings from reduced losses, and better service to the consumer.

Many of you may have thought of the improvement in distribution if the voltage supplied the domestic and commercial consumers could be made double its present value, and the thought of the tremendous change required to do this has made you hesitate to mention it, much less recommend it.

It is interesting to note the recent decision to standardize 230 volts as the voltage of all lamps and domestic appliances in Great Britain. In Great Britain at the present time the load connected to the systems supplying lamps and appliances at 200 volts and over is 24 times as great as the load connected to systems supplying lamps, etc., at less than 200 volts. The highest voltage rating for lamps is 250. The voltage used for cooking and heating is as high as 460 volts, but the voltage of 200 to 250 predominates.

In the Commonwealth of New Zealand the secondary distribution is 230–400-volt, three-phase ; the lamps and appliances are therefore 230-volt. This practice is also being followed in many European countries.

The ranges made in Ontario for export are equipped with 230-volt

elements. These are exported to the United Kingdom, Australia, New Zealand and British South Africa. The report of the Department of Trade and Commerce of Canada shows the value of electrical domestic cooking and heating devices exported in the period April 1, 1929, to December 31, 1929, to be approximately $491,000.00.

Assuming that the single-phase, 115–230-volt secondary will remain the standard on practically all systems, it should be operated at its maximum efficiency by supplying all possible load at 230 volts. This will have been done when load unbalance has been eliminated. The energy loss on a secondary supplying a given load at 230 volts is only one-quarter as great as at 115 volts. At the same time the per cent. voltage regulation is four times better at 230 volts than at 115 volts.

The causes of unbalance are :—

1. Large capacity two-wire, 115-volt services.
2. Three-wire services having branch circuits not properly balanced.
3. Single-phase motors supplied at 115 volts which should be supplied at 230 volts.
4. Two-wire, 115-volt heating devices drawing more than 15 amperes.
5. Electric ranges or heaters wired 115–230 volts, three-wire, but not so constructed as to ensure load balance during normal operation.

On account of the larger load, due to the great number of heaters and ranges on our Systems, the first three causes above named are not as important to us as the last two. They have been included to complete the discussion on unbalance and to suggest their correction.

As the number of ranges supplied from one transformer increases, the unbalance on one service may tend to offset that of another, and balance is more nearly realized as far as long street secondaries and transformers are concerned. However, the unbalance is still present on the service wires and short sections of street secondaries. The total of all this loss caused by unbalance is a substantial figure, and is an economic waste which must ultimately be paid for by the consumer in his rates for service.

Unbalance adversely affects good voltage regulation, the voltage being low on the heavily loaded side of the circuit and higher on the lightly loaded side. This detracts from the good quality of service to the consumer and decreases his satisfaction in the appliances he owns.

With a small capacity transformer connected 115–230 volts this unbalance may cause its voltage drop to nearly equal the drop on the secondaries. When considering the overload capacity of a transformer connected 115–230 volts with one side only carrying load, we must not assume that the transformer will only carry half its rating under these conditions. It will carry considerably more, since the mass of material in the whole transformer absorbs heat from the one coil during short overloads. Similarly on a steady overload the oil and radiating surface of the whole transformer conducts heat away from the one coil. The primary fuse cannot be relied upon to prevent burn-out due to overload of one coil, since the fuse is large enough to

handle overload on the whole transformer.

Electric ranges having 115-volt elements connected between outer and neutral, may be balanced when all elements are switched on at the same time. During operation in service, however, the load of the range is nearly always unbalanced. Tests which have been made show that the greater part of the energy supplied to ranges is supplied at 115 volts, it being seldom that elements connected to opposite sides of the circuits are used together. This unbalance has so much effect on the voltage on each side of the service that it is a regular thing on some systems, when testing voltage at consumers' premises, to use two voltmeters, one connected to each side of the service.

When ranges were first connected to the smaller systems, before such systems had been rebuilt using shorter transformer spacing and larger secondaries, the unbalance due to a single range gave considerable trouble, and the voltage on the lightly loaded side would rise to such an extent that a low wattage element would burn out in a short period of service. The voltage on the heavily loaded side dropped so low as to make it impossible to do satisfactory cooking. In some of these cases the consumers' normal use of the various elements was determined, and a change made in the range wiring to improve balance of the elements mostly used. This served to tide over the time until more capacity was added to the system. Later, when two or more ranges had been connected on a certain street and unbalanced conditions were evident, the two outer wires of one or more services would be reversed and better balance obtained on transformer and secondaries.

Auto transformers, or balance coils as they are sometimes called, are manufactured as a standard article, and they are sometimes used to maintain voltage balance caused by unbalanced load at the end of a long 3-wire secondary. They may be used to supply 3-wire service at the end of a long 2-wire 230-volt extension from a 3-wire, 115–230-volt secondary.

Fig. 1 shows one of these balance coils with a section of a voltage chart taken to show that the balance coil improved the voltage supplied to a range. This test was carried out on a large System with large capacity transformers and secondaries ; hence the improvement in voltage balance by the use of the balance coil was not as great as it would have been if it were used on a System with smaller capacities where there would be greater voltage unbalance to be corrected. On this range the two oven elements and a small surface element were connected to one side of the circuit, while the remainder of the surface elements were connected to the other side of the circuit. The voltmeter was connected to the same side of the circuit as the oven. The voltage on one side of the circuit was recorded with different loads, with the balance coil ; and then the same loads were separately switched on without the balance coil in circuit.

It is noted that when all the elements of the range were on high heat, the voltage was the same whether balance coil was in circuit or not. The load must have been practically balanced, and the balance coil was of

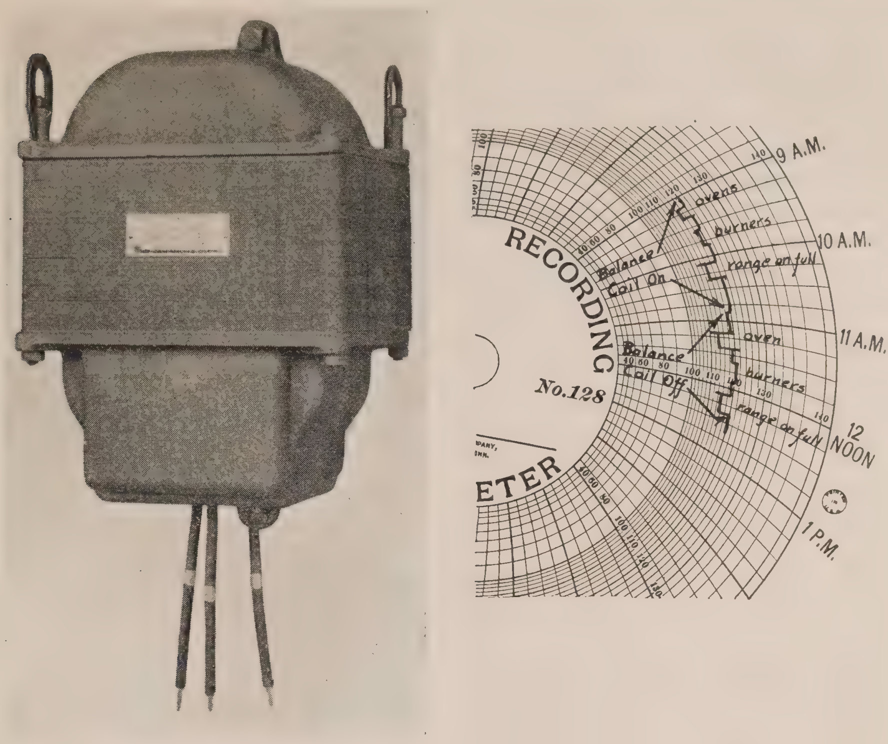


Fig. 1—Balance Coil and section of Voltage Chart showing improvement in voltage supplied to a range when the coil was in the circuit.

no use in that case. With only surface elements on, the voltage on one side of the circuit was slightly higher when the balance coil was not connected, showing that with load unbalanced, the balance coil tended to equalize the voltage on each side of the circuit. When oven elements only were on the voltage supplied to them was much better with the balance coil connected than it was when the balance coil was not connected. This shows again that the balance coil improved the voltage balance with unbalanced load.

A heater switch known as The Balanced Load Switch came on the market more than two years ago, and some makes of ranges in the United States have been equipped with these switches.

Having experienced some trouble with unbalance on transformers and secondaries caused by electric ranges, the Engineers of the Ontario Hydro Commission were attracted by an announcement which appeared in a United States magazine early in 1928, to the effect that ranges manufactured by a particular Company were being equipped with Balanced Load switches. In order to determine how far Canadian manufacturers had progressed in the matter of properly balancing the load of their ranges, a letter was sent on March 9th, 1928, to each Canadian manufacturer supplying ranges to the

Ontario market, referring to the advertisement of the U.S. manufacturer and soliciting information on the developments along similar lines by these manufacturers. The replies which were received indicated that few of the Canadian range manufacturers were aware that the equipment was available to reduce the unbalance in load of the ordinary range. They all indicated, however, a desire to co-operate and make a study of the matter and let us know the results of their investigations. The consensus of opinion among these manufacturers was that considerable change would have to be made in the design of the ranges which would add considerably to the cost. Also, with the balanced load switch the wiring would be more complicated, thereby increasing the difficulties of the one called in to service the range. The manufacturers felt that unless there was an insistent demand for ranges equipped with load balancing devices, they would hesitate to go very far in the development of this kind of equipment. One manufacturer expressed the opinion at that time that 230-volt elements would be more suitable than Balanced Load switches, providing the elements were covered and both sides of the circuit fused as is required.

When this matter was broached in March 1928, one manufacturer voluntarily agreed to produce some ranges equipped with Balanced Load switches and place them on test for our information, but so far none have been received. One manufacturer has just adisved that he is now submitting a range equipped with Balanced Load switches to the H.E.P.C. Approval Laboratory.

Fig. 2 shows the operation of a Balanced Load Switch, and Fig 3 shows a wiring diagram of a range equipped with these switches. This switch is so constructed that the two 115-volt halves of each element are connected in series across 230 volts when the element is on high heat. On medium or low heat the element is supplied from one conductor and neutral. This switch lessens load unbalance, since all elements are on 230 volts when on high heat. It does not entirely eliminate unbalance, as the elements are connected across 115 volts when on medium and low heat.

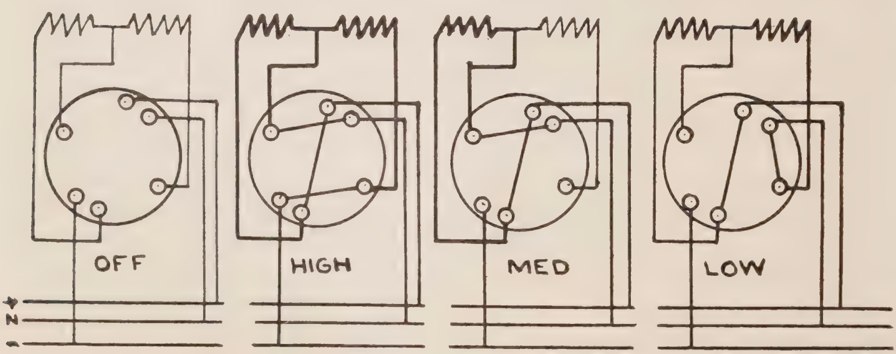


Fig. 2—Balanced Load Switch, Four positions showing the way elements are connected.

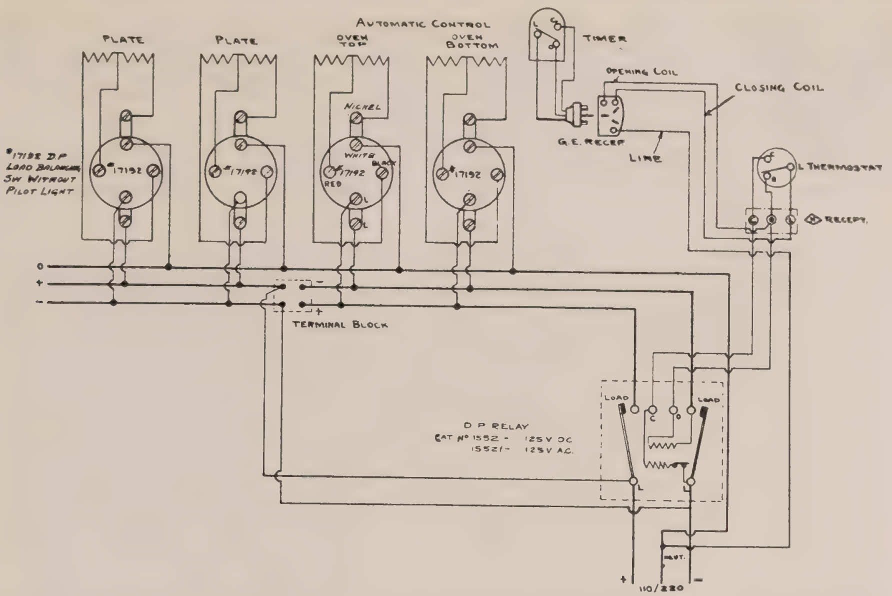


Fig. 3—Wiring diagram of a range equipped with Balanced Load Switches.

In some types of Balanced Load switches all the elements of the range, when on medium or low heat, are connected to the one side of the circuit, and it is then possible to have the same amperes unbalance as with a range not equipped with these switches. For this reason some engineers object to the use of the name "Balanced Load" switch. It should be possible to arrange the wiring so that half the load of the medium heats would be connected to one conductor and half to the other, then better balance would be obtained. The unbalance on a range equipped in this way could never be more than one-half that of the ordinary range. Some claim that it is not necessary to have the medium heats balanced or on 230 volts, for the reason that slow cooking is not objectionable on medium heat. This is not entirely correct, because on medium heat (115 volt element.) the current is doubled what it would be for the same wattage element operating at 230 volts. This larger current causes greater voltage drop and any other elements operating on high heat, at the same time as those on medium heat, recieve less voltage than they would if all elements were 230 volts. One type of this switch is so constructed that the neutral wire is connected through to the middle point of the element the two halves of which are connected accross 230 volts. Should one-half of the element be broken or burned out, the other half of the element would operate at 115 volts. On 3-phase, 4-wire systems it is necessary that the switch make this neutral connection to ensure each half of the element of its full voltage.

It is on high heat that fast cooking is desired by the consumer. Balanced Load switches assure the consumer of the best voltage the system can supply when it is desired for fast cooking. The consumer is not so concerned if cooking is slow on medium

heat. This switch does not fulfil the ideal requirements of the supply system, since a great deal of the energy supplied the appliance would still be at 115 volts with its greater loss than if supplied at 230 volts. For this reason the best arrangement is 230-volt elements throughout. This would completely eliminate unbalance and provide minimum losses.

It is admitted that the use of 230-volt elements would present a problem

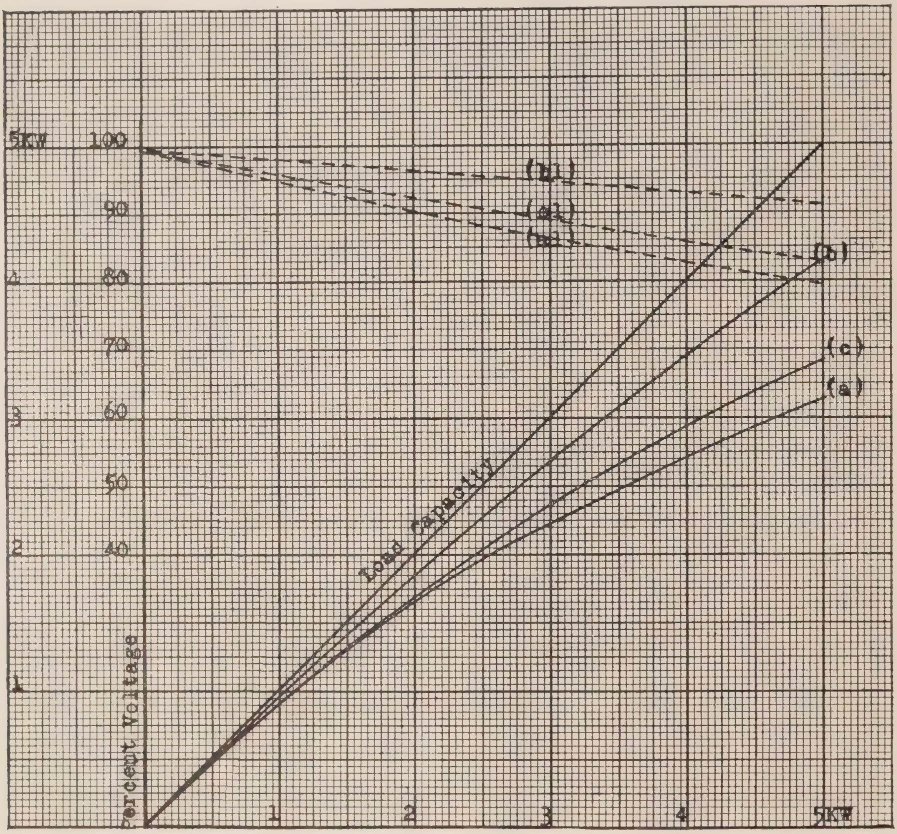


Fig. 4—"Actual Input" and "Per cent. Voltage" at Load Terminals.

Load 500 ft. from transformer and No. 6 copper secondaries.

(a) Actual Input using 3 kv-a. 115–230 and all load at 115 volts.
(b) " " " 3 kv-a. " " " " " 230 "
(c) " " " 5 kv-a. " " " " " 115 "

(a1) Per cent. Voltage at load under condition "a".
(b1) " " " " " " "b".
(c1) " " " " " " "c".

on 115–200-volt, 4-wire, 3-phase secondary net works which may be installed in the future. Existing 230-volt waterheaters on this system would receive only 200 volts. The heater will have to be redesigned for 200-volt operation, or provided with 115-volt elements and controlled by a Balanced Load switch with neutral connected when on high heat. Furthermore, as pointed out above, the use of such low voltage net works has only a limited application and will affect very few of the total number of ranges or heating devices in service. These low voltage net works are installed at the present time only in business sections with high load density, having few domestic devices.

In the supply of service for ranges on the farms, the conditions are different from those in towns and cities. The standard farm installation is supplied from an individual 3 kv-a. transformer, as long as consumer operates satisfactorily with 35-ampere main fuses. Any unbalance on one service is not offset by unbalance on another ; the transformer and secondary wiring must carry it. Statistics show that the demand of a single range is about 3.61 kv. which is a reasonable load to be supplied by a 3 kv-a. transformer. Can we assume that half the load of the range will be supplied by one-half the transformer ? Results show that we cannot, as it is often found that half of the transformer is overloaded, while the other half supplies little or no load.

The effect of range unbalance upon the voltage supply to a farm service may be very serious. A 3 kv-a. transformer is placed on the highway and three secondaries are run in over private property to the service entrance. The farmer pays for this line on his property. The secondary is run on private property because lines operating at secondary voltage are considered safer on private property than at primary voltage. If the farm buildings are more than 500 feet from the highway the primary line is constructed on private property and the transformer is located near the service entrance.

In order to show the effect of unbalance under average conditions, a wiring diagram of each make and type of range was made showing the different elements, their wattage, and to which side of the circuit they were connected. Four ranges of the size and type found on the farms were selected. Certain combinations of elements were assumed to be switched on and calculations were made to show the voltage obtained at the elements. The results represent normal operating conditions, except that primary voltage was assumed to be constant. The distance from transformer to range was taken as 500 feet. The voltage regulation was calculated as a percent. drop on each side of the 115–230-volt secondary ; also for comparison as a percent. drop assuming that all elements are operated on a 230-volt, 2-wire service.

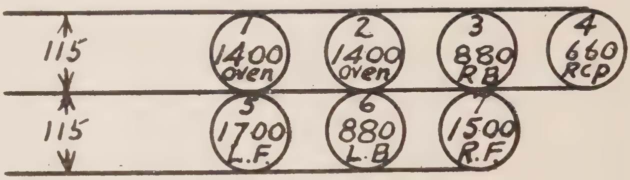
The average of the equivalent resistance values (high and low tension) from three makes of 3 kv-a. transformers, gives a value of 0.62 ohms or a resistance of 0.31 ohms per 115-volt winding. The resistance of 500 feet of No. 6 copper wire was taken as 0.19 ohms

In the four examples tabulated below it is assumed that the front surface elements are the ones most used. In examples No. 7 and No. 11 if the connections to one of the front surface elements and the top oven element were interchanged so that the oven elements would be on opposite sides of the circuit and the two front surface elements on opposite sides of the circuit, much better balance would result under normal operation.

Example #7

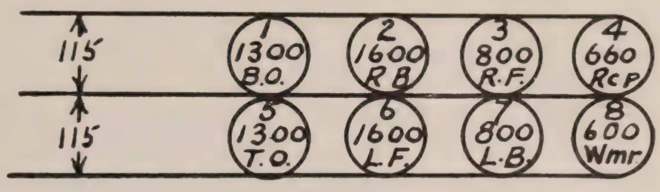
Stove	Elements Switched on	Three-wire Service 115–230 Volt: Volts on Load		Three-wire Service 115–230 Volt: % Drop		Two-wire 230 Volt Service: Volts on Load	Two-wire 230 Volt Service: % Drop
No. 7.	5—6—7	97.7		15.0		216	6.1
	1—2	102		11.3		220	4.3
		(1)	(5&6)	(1)	(5&6)		
	1—5—6	112.2	104.1	2.44	9.47	215	6.5
	1 medium—5—6	115	103	0	10.4	217	5.65

Example #11



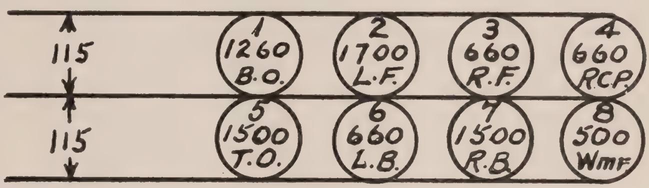
Stove	Elements Switched on	Three-wire Service 115–230 Volt: Volts on Load		Three-wire Service 115–230 Volt: % Drop		Two-wire 230 Volt Service: Volts on Load	Two-wire 230 Volt Service: % Drop
No. 11.	5—6—7	94.7		17.7		213.8	7.04
	1—2	100.5		12.6		218	5.2
		(1)	(5&6)	(1)	(5&6)		
	1—5—6	110.5	103.3	3.9	10.2	214	6.95
	1 medium—5—6	114.8	102.2	0.2	11.1	216.5	5.87

Example #13



Stove	Elements Switched on	Three-wire Service 115–230 Volt: Volts on Load		% Drop		Two-wire 230 Volt Service: Volts on Load	% Drop
		(3)	(6&7)	(3)	(6&7)		
	6—3—7	113.8	103.2	1.4	10.3	217	5.65
	1—5	109.7	109.7	4.6	4.6	219.4	4.6
No. 13.		(1&3)	(6)	(1&3)	(6)		
	1—3—6	105.8	109.7	8.0	4.6	215	6.52
	1 medium—3—6	109.2	108.5	5.04	5.65	217	5.65

Example #19



Stove	Elements Switched on	Three-wire Service 115–230 Volt: Volts on Load		% Drop		Two-wire 230 Volt Service: Volts on Load	% Drop
		(2&3)	(6)	(2&3)	(6)		
	2—3—6	103.2	114.6	10.2	0.35	218	5.2
No. 19.		(1)	(5)	(1)	(5)		
	1—5	110	108.2	4.35	5.9	218.5	5.0
	1—2—3	96.7		15.9		215.5	6.3
	1 medium—2—3	99.8		13.2		216.3	5.95

Four normal operations are represented in these examples by assuming the use of :

(1) Three surface elements on high heat.

(2) Top and bottom oven elements on high heat.

(3) Bottom oven and two surface elements on high heat.

(4) Bottom oven on medium heat and two surface elements on high heat

These results show that satisfactory service cannot be supplied at 115–230 volts under most of the conditions selected, except Examples No. 13 and No. 19, with (1 and 5) one oven element connected on each side of the circuit. This results in regulation of 4.6 per cent. and 5.9 per cent. respectively. The satisfactory results that would be obtained with all elements 230-volt, 2-wire, are shown in the tabulation to the right. In no case does the per cent. drop exceed 7.05 per cent. as compared with 17.7 per cent. with 115–230 volts.

Curve Fig. 4 assumes voltage at high tension terminals of transformer to be constant, and shows the percent. of rated voltage and actual watts supplied. Assume 3,000-watt load turned on and refer to Fig 4. With 3 kv-a. 115–230-volt transformer and the load all on one 115-volt coil, the load receives only 2240 watts at 86.5 per cent. rated voltage. If 5 kv-a. is substituted for the 3, this increases to 2370 watts at 89 per cent. rated voltage. If the load were 230 volts with 3 kv-a. transformer, 2680 watts at 94.6 per cent. rated voltage would be supplied.

Tests have been made on consumers' premises to get results under normal operating conditions. Each test set consisted of two graphic ammeters and two graphic voltmeters. One of each was connected to each side of the circuit. The current and voltage on each side of the circuit was measured simultaneously. In some cases the current to the range only was measured, and in others the current of the whole service.

The charts, Figs. 5, 6 and 6a serve to show the nature of results obtained. It will be observed that the loads were seldom in balance.

On systems in cities and towns the bad effect of load unbalance on the service to the consumer is being overcome by larger secondaries and larger transformers with closer spacing, thus increasing capital cost per consumer. This is putting up with the trouble—not eliminating it. Are we justified in increasing the capital cost per farm consumer to do the same ?

Corrections of the five causes of unbalance as detailed above are :—

(1) Place a limit on the capacity of two-wire, 115-volt services.

> It is suggested that only services supplying two branch circuits or less be made 2-wire—capacity of branch circuits 1200 watts each.

(2) Include in wiring rules the balancing of circuits.

(3) Place a limit on the capacity of motors which may be connected 115 volts.

> It is suggested that motors larger than ¼ horse-power be connected 230 volts.

(4) Specify that heating devices drawing more than 15 amperes be made 230 volt, two-wire.

> In the cause of safety it might be recommended that all air heaters be made 230 volts. This would ensure their use in safe locations on proper circuits. As long as they are 115-volt their use in dangerous places on lamp sockets cannot be prevented. Fatalities have occurred under these conditions.

(5) Specify that all electric ranges and heating appliances drawing more than 15 amperes be manufactured with 230-volt elements.

> This would not render the appliance more unsafe, because the con-

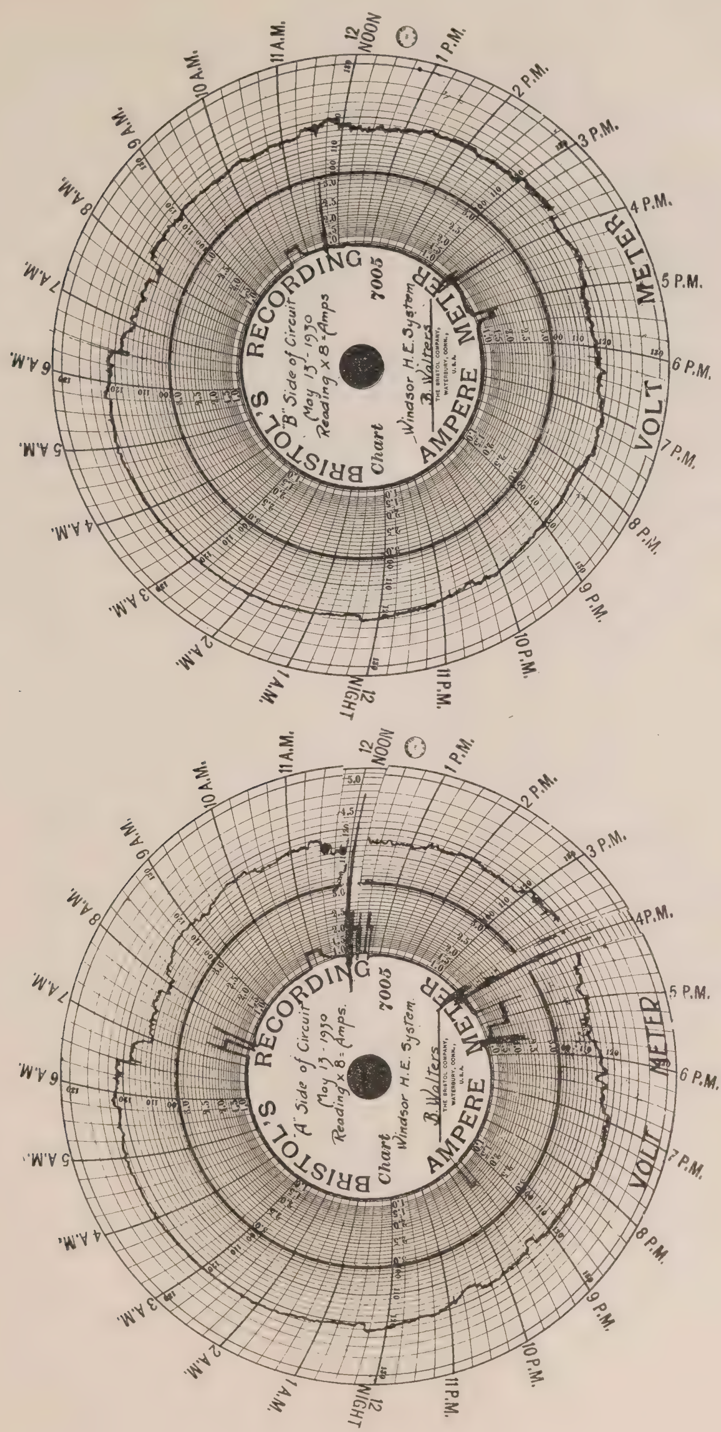


Fig. 5.—Current and Voltage Records of a range in service.

Note:—Most of the load is on side A. The lower voltage on side A indicates larger load on side A than side B of street secondaries.

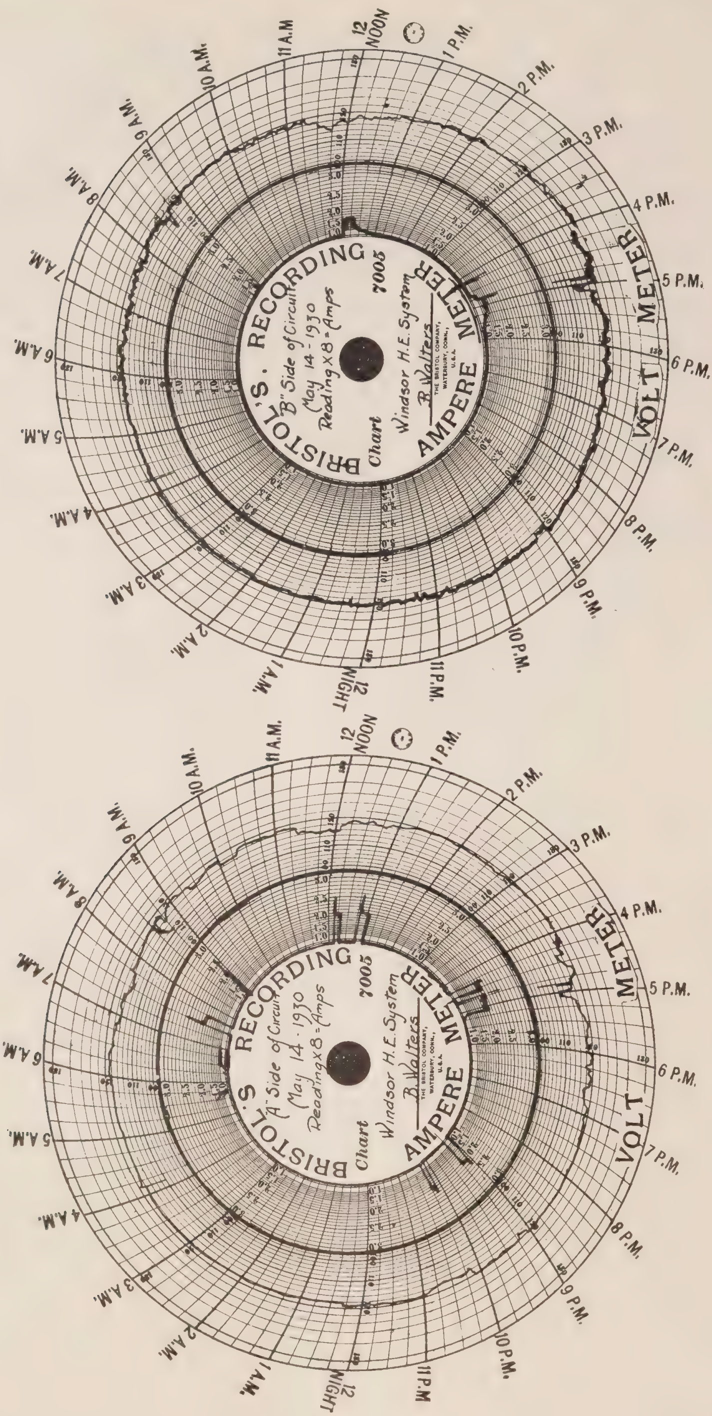


Fig. 5a.—Another day's test of the same range as in Fig. 5.

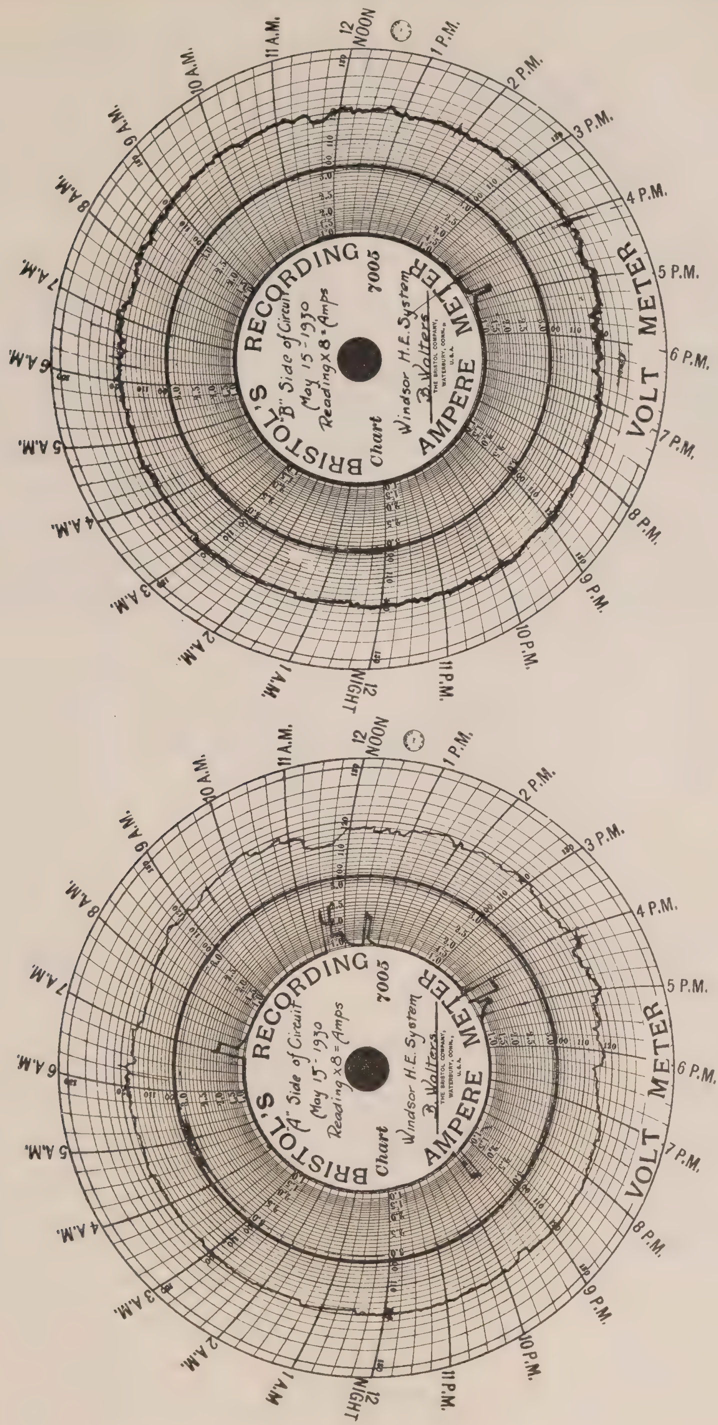


Fig. 5b.—A third day's test of the same range as in Fig. 5.

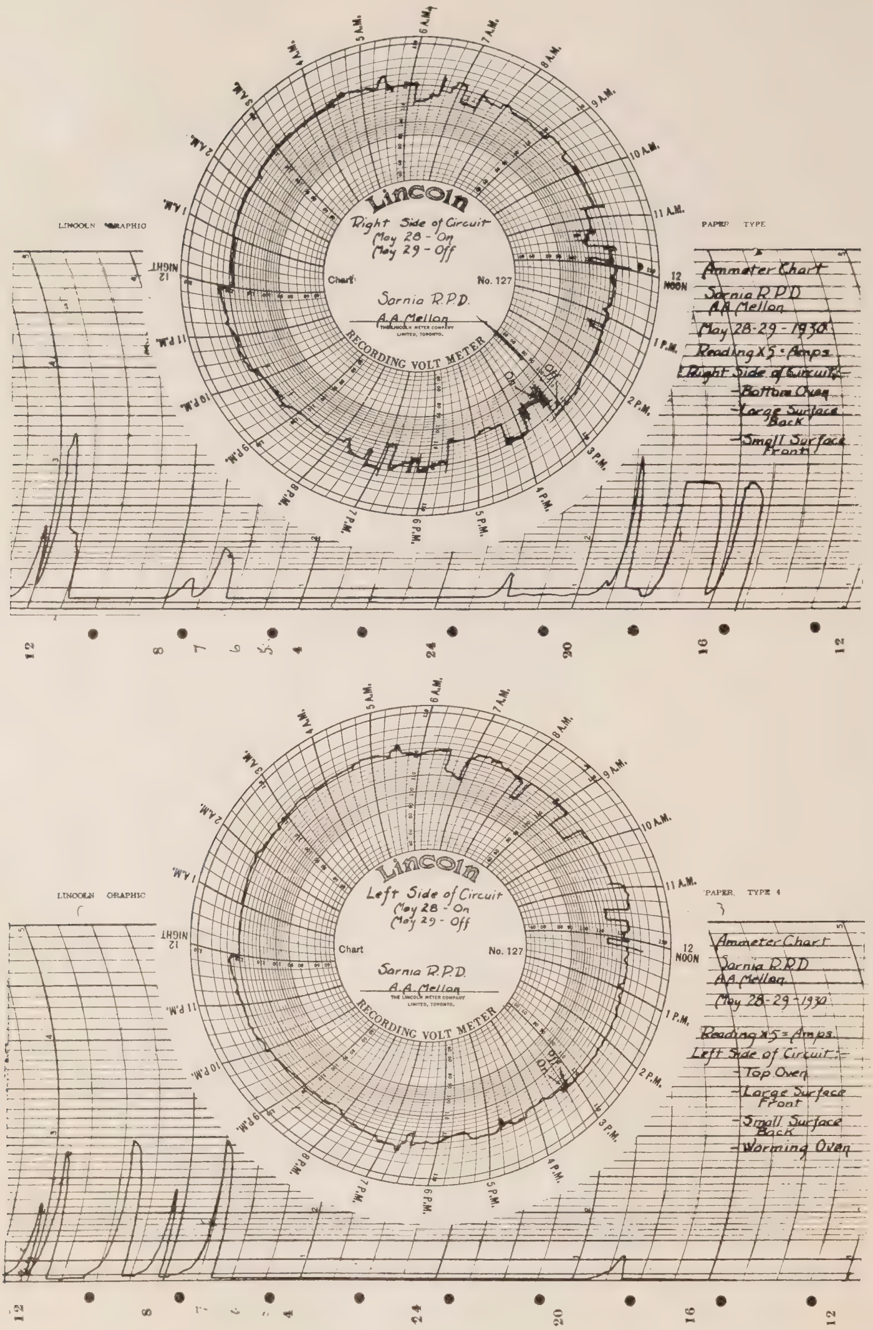


Fig 6.—Current and Voltage records of a combined range and lighting load on a small farm service supplied by an individual 3 kv-a. transformer over 105 ft. of 3 No. 6 copper secondaries and 207 ft. of 3 No. 8 copper service wires.

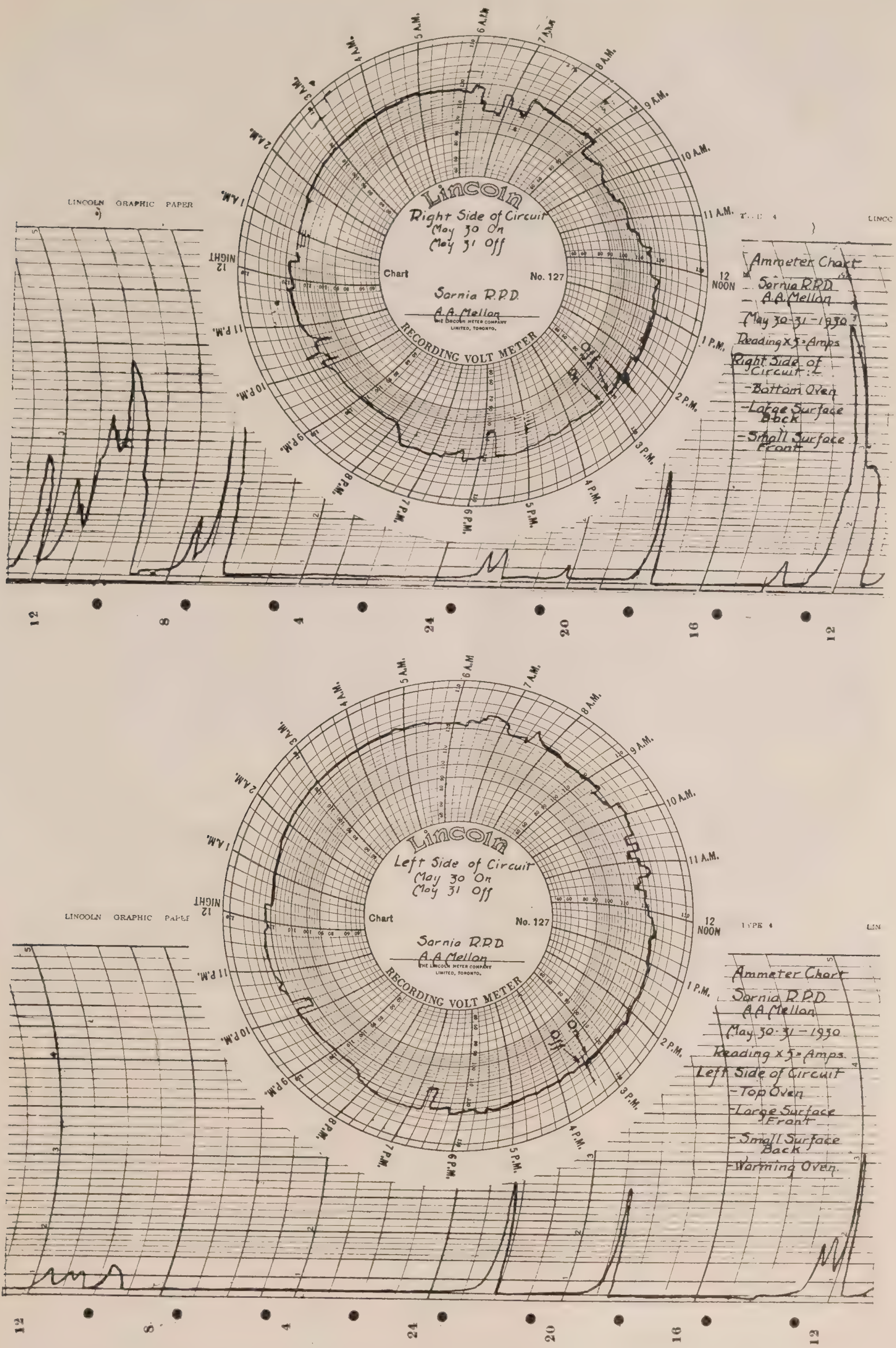


Fig. 6a.—Records from the same service as Fig. 6, but for another day.

ductors would still be the same voltage to ground. Two fuses on each element would properly protect them. Double pole switches would be required, but their contacts would carry one-half the current of the present switches, so should last longer. The internal wiring of the range would require two wires instead of three, thereby simplifying the range wiring. The 230-volt elements on ranges, made for export, and the elements and double pole switches on the present 230-volt electric water heaters, have given satisfactory service, so no trouble is anticipated from them when installed on ranges and other heating appliances.

I have attempted in the foregoing to gather together all available data on the subject in the short time at my disposal. I trust that this will bring about a full discussion, and that regulations will be made to eliminate this secondary unbalance, thereby improving the service to the consumers on our Hydro Systems in Ontario.

Appendix

After the paper had gone to press a Balanced Load range was received at the Approval Laboratory. On this range all the elements except the warming oven are controlled by Balanced Load Switches, and are connected across 230 volts when on high heat. The mid points of the elements are also connected to the neutral when on high heat. The warming oven has one heat and connects across 115 volts.

In order that all the medium heats will not be supplied from one side of the

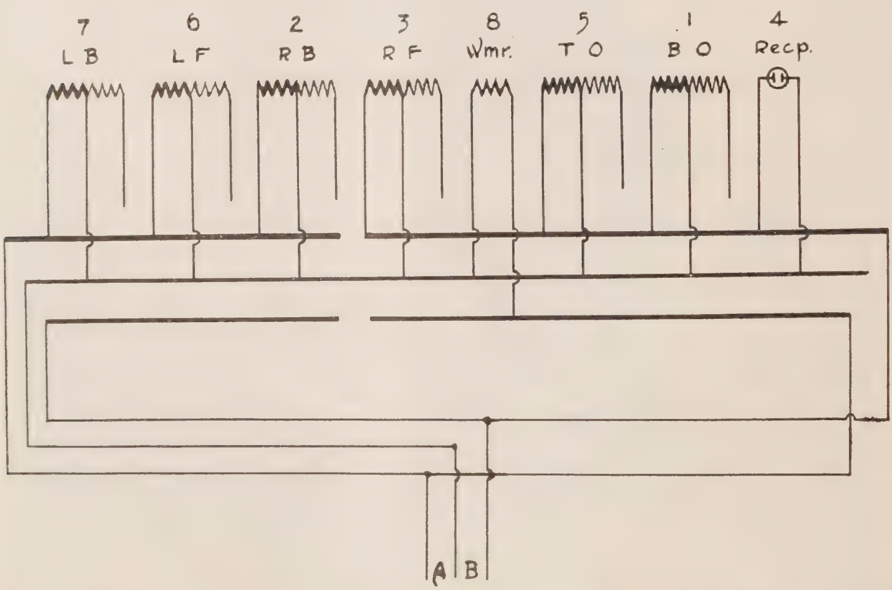


Fig. 7.—Wiring Diagram showing the method of connecting the Balanced Load Range so that all medium heats will not be supplied from one side of the circuit.

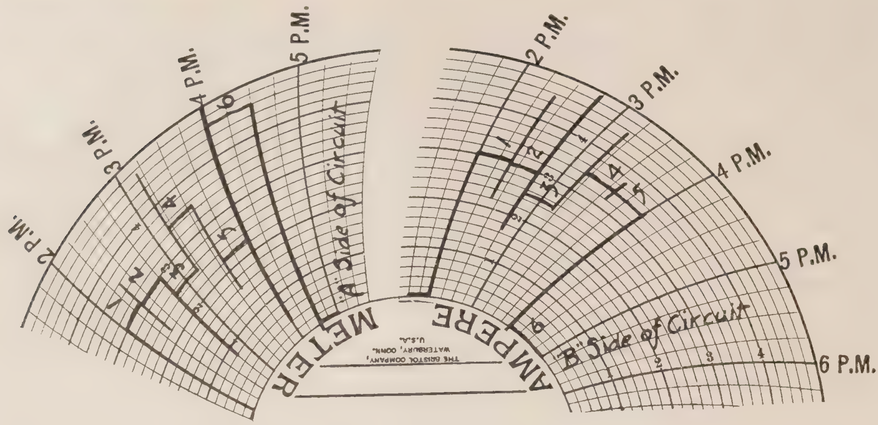
circuit, the busbars are in two sections and one section is cross-connected. (See wiring diagram Fig. 7). In this range each switch base and fuse block is in one piece. Three copper straps run horizontally across the porcelain block, and the bus is made continuous by copper links between the ends of each strap. All these blocks are mounted side to side, making a very compact assembly. It is not apparent to the writer how the installation of these switches would increase the cost of the range, or make the wiring any more complicated, or increase the difficulty of servicing the range.

The number and size of the elements on this range correspond to Example No. 13, and for this reason the elements have been allotted the same numbers as in Example No. 13. The actual location of the switches relative to one another is as shown in Fig. 7. The manufacturers rating of the elements has been used in this tabulation, but the exact wattage will vary slightly in different elements of the same rating. The watts rating of the elements, and the side (A or B) of the circuit to which they will be connected when range is in operation, is shown in the following tabulation:

This shows that the worst possible unbalance with this range is 3000 watts when elements 6, 7 and 2, are on medium heat along with the warming oven. During normal operation it is improbable that this use of the elements would occur. The worst possible unbalance with the ordinary range of the same capacity Example No. 13 is 4300 watts. This range is a great improvement in load balance over the ordinary range. The ammeter charts (Fig. 8) taken during the test of the range show the excellent load balance obtained by this range during normal operation. It will be noted that the charts (Fig. 8) record the current resulting from the same combinations, of the elements, in use as set out in Example No. 13. In addition the chart shows the maximum unbalance, but Example No. 13 does not show the result with maximum unbalance of the ordinary range.

If the design of the range made it necessary to have the fuse block separate from the switch base; this assembly would be more flexible for balancing the medium heats than the one described above, because the wires between any fuse block and

	Low Heat	Medium Heat	High Heat	
Elements	Watts Side B	Watts Side B	Watts Side B	Watts Side A
1. Bottom Oven...	425	650	650	650
5. Top Oven......	425	650	650	650
3. R.F. Surface....	200	400	400	400
4. App. Receptacle.		Est. 660	Est. 660	
	Watts Side A	Watts Side A		
6. L.F. Surface.....	400	800	800	800
7. L.B. Surface....	400	800	800	800
2. R.B. Surface....	400	800	800	800
8. Warming Oven..		600		600



Readings × 5 = Amperes.

Fig. 8.—Ammeter sharts of the Balanced Load range under test. The Charts show the load balance to be expected under normal operating conditions and also the worst possible case of unbalance with the range.

switch could be cross-connected. Then the medium heats, likely to be used simultaneously, would be connected to opposite sides of the circuit.

Amperes on each side of the circuit as recorded by the Charts Figure 8 are tabulated below :

Amperes on each side of the circuit as recorded by the Charts Figure 8 are tabulated below :—

Elements Switched On					Amperes Load.		
					A.	B.	Test
All High	6 L.F.	3 R.F.	7 L.B.		15.2	15.2	1
	6 L.F.	2 R.B.			14.8	14.9	2
	Oven	1 and 5			12.6	12.4	3
	1 B.O.	6 L.F.	3 R.F.		17.3	17.2	4
	1 B.O. (med)	6 L.F.(high)	3 R.F. (high)		11.3	17.1	5
Med.	7 L.B. (med.)	6 L.F.(med.)	2 R.B.(med.)	8 Warmer	23.0	0.0	6

Discussion

Mr. Lawler:

Mr. Chairman, Ladies and Gentlemen: Last March, the Manager of a Hydro System in one of the cities in the Province, wrote a letter to the Hydro-Electric Power Commission of Ontario, pointing out trouble he was having due to secondary load unbalance. I want to read one sentence from that letter. "It has been suggested that your approval of electrical apparatus might enable you to have the manufacturers make a change in the balance of the elements on the ranges." This question was taken up by the Papers Committee at their meeting in April, and they decided that this would be one of the subjects for your consideration at this Convention.

Since the advance copies of the paper were sent out, I have received a letter from another manufacturer, part of which I will read. I also have here the sample of a panel board of the range with these switches in case you wanted to see them. This letter says, in part, "We wish to call your attention to the particular advantage of our load balancing switch. The writer notices in your paper you refer to ranges that are designed to take separate switches and cut-outs being more flexible in balancing the load. You will note that our load balancing switch is made with an interchangeable shunt, which will enable you to change any burner on the stove from one side to the other." He means there any burner on medium heat because on high heat the two halves of the elements are in series across 230 volts. "We think this will be even more flexible than a separate switch and cut-out. At least it will be more practicable and easier to change on a range which your service man might find unbalanced."

The letter then makes an assumption of the medium heats which will be used together, and enclosed is a wiring diagram showing how they can be balanced.

This is the panel board of this particular range. These three straps on the back are the busbars and they support the switch and fuse blocks and are themselves supported by the porcelain blocks at each end. The top strap is the neutral and the two lower the outers or phase wires. This lower bus is cut to allow for the use of automatic oven control. If automatic oven control is used the medium heats of the two oven elements must be both on the same side of the circuit.

The medium heat of any of the other elements can be supplied from whichever side of the circuit desired by taking out these two screws with this metal strip or shunt, and moving them to the opposite positions. The end of the element which was connected to this middle busbar is now connected to the lower busbar while the other end of the element is changed from the lower to the middle bus.

Mr. J. E. B. Phelps, Sarnia.

Mr. Chairman, all the different Utilities will agree that the bugbear of distribution is unbalance. I think he has hit the nail on the head when he made the suggestion to have the elements for ranges and various heating appliances made for 230 volts. When I heard Mr. Lawler read his paper, the point that struck

me was that if the range manufacturers were making 230-volt elements for export business, surely we could obtain them for home use in Ontario. I would like to see some recommendation made by this Association to the proper authorities to see if the manufacturers will not supply a 230-volt element, which will get us out of the biggest part of our difficulty, namely, the inefficient distribution of power on account of the unbalance.

Mr. P. B. Yates, St. Catharines:

Mr. Chairman, the subject of unbalance on stoves has been in my mind for some time. I brought it up a number of years ago at a Convention, and at that time spoke to one or two of the manufacturers about balancing their elements as much as they could, using a 110-volt element across the three wires, putting one oven element on either side of the circuit, one large element on either side, and one small element on either side. Well, that gives you a much better condition than we have had in most of the stoves. I think, however, that Mr. Lawler's suggestion of 230-volt elements, and then balancing the medium heats on either side of the three wires, is a much better one. I believe that, as we have such a large number of stoves on our systems, it is worth while for the municipal systems to spend considerable time in research in the work of balancing stove loads, and I would suggest that a Committee be appointed to co-operate with the Engineers of the Commission to continue the study of this matter.

Mr. J. J. Jeffrey, H.E.P.C. of Ont.:

Mr. President, the Commission are going to a great deal of trouble to get power for the municipalities. After they deliver it to you, there is about a 20 per cent. loss in your distribution systems, so that approximately 20 per cent. of all the power which you buy is used up in losses. If anything can be done to reduce these losses, it is certainly something that should be followed up.

Mr. R. H. Starr, Orillia:

Mr. Chairman, if there are any manufacturers here, I think we ought to hear from them as to the advisability of the 230-volt element.

Mr. M. J. McHenry, Canadian General Electric Co. Limited:

Mr. Chairman and Gentlemen, before saying anything in this connection, I want to congratulate Mr. Lawler on his very excellent paper, and to add that I think it evidences a great deal of care and a vast amount of work in getting the information and presenting it to us in such a capable and satisfactory manner. I cannot speak for all the range manufacturers in reference to the question of the 230-volt elements on ranges, but I can say that 230-volt elements are entirely practicable, and can be supplied without any great degree of difficulty. It would seem that, according to his paper, Mr. Lawler suggests the 230-volt element for use in ranges is one which will most satisfactorily meet the conditions of unbalance, and if they can be supplied—and I know that they can be supplied quite satisfactorily—I think probably it is very largely the answer to the situation in so far as stoves are concerned. There are other ways of doing it, but I think this paper clearly brings out the point that some of the other methods are not nearly as

close to the 100 per cent. mark as is the 230-volt element.

Mr. H. F. Shearer, Welland:

Mr. Chairman, I should like to hear as to whether there is any record of the life of the 230-volt elements, as compared with the 115-volt element.

Mr. W. P. Dobson, H.E.P.C. of Ont.:

I am not able to speak as to the life of the element. The manufacturers would be more able to speak of that, especially the manufacturers who export to New Zealand and make elements for use on 230-volt distribution.

There are one or two points in connection with Mr. Lawler's paper that I think were very well taken, and one or two others which might offer a little difficulty. The matter of rules is something which, of course, we have to follow. We cannot always lead. It is hard enough for the inspection department to make rules after we have started distributing the power and to enforce them without adding on the difficulty of making rules before the practice of distribution for any system is started. That is putting it a little stronger, perhaps, than I had intended, but my point is simply that it would hardly be within the power of the inspection department to follow the suggestion of requiring load balancing, because it is not essentially a matter of safety. An inspector is interested only in safety, and not especially in load balancing, only in so far as it influences the safety factor. There is one point Mr. Lawler made which I do thoroughly agree with, and that is the greater use of 230-volt electric heaters. Electric heaters are one of the chief causes of fires, and a portable heater is, perhaps, the greatest cause of fire. If we could reduce the number of portable heaters without inconvenience to the householder, I think it would be a great step in the direction of safety.

Mr. E. V. Buchanan, London:

Mr. Chairman, seeing there seems to be no one here who can tell anything at all about the life of the 230-volt element, might I say that several engineers from New Zealand and Australia have visited London to inspect the McClary plant, and while they were there called at my office. I asked them what they thought about the 230-volt stove element, and they invariably answered that they were entirely satisfactory. In England, practically all voltage is from 200 to 250, and they seem to have no serious trouble with the higher voltage elements there. I am quite sure that 230-volt elements can be made exactly in the same way as we now have the 115-volt elements, without reducing the life or increasing the maintenance.

Mr. T. C. James, H.E.P.C. of Ont.:

Mr. Chairman, the only way we can get any definite action is through a Committee of this organization, who will get in touch with the manufacturers and see if something cannot be done to bring about a remedy.

Mr. Buchanan:

Mr. Chairman, there was, at the Winter Convention, a small Committee appointed on research, distribution and utilization. Wouldn't that be the right Committee to refer this matter to?

Mr. Yates:

Mr. Chairman, in answering that question, I move that this subject

be referred to the Committee mentioned by Mr. Buchanan for investigation and report.

Mr. Phelps:

I second the motion.

(Motion Carried.)

Mr. Lawler:

Mr. Chairman, there were one or two other points in the paper that I touched on. For instance, the large two-wire service and the three-wire service that is not properly balanced. I don't think we have given that enough thought. What is your idea—to have the Committee deal with that, too, or just the ranges? We find, in going through the country, a good many services, two-wire of large capacities, and the wiring inspector has no power to make them three-wire. As long as they put in the proper fuses and the proper sized switches, nothing can be done. This causes a very bad unbalance on the distribution system, and that is why I put it in the paper. The other point was, we run a three-wire service into a farm, and we often find the lighting circuits all on one side of the circuit; the inspector has no power to make the wiremen balance that load. Those are two points I would not like you to lose sight of.

Mr. Yates:

Mr. Chairman, the different points covered in this paper should all be discussed.

Chairman:

That Committee was composed of Messrs. E. V. Buchanan, C. E. Schwenger and O. M. Perry. I believe they are all present, and can take a note of what they have to do.

Public Utilities Commission,
Hanover, Ontario.
July 10th, 1930.

Mr. E. R. Lawler,
190 University Ave.,
Toronto, Ont.

Dear Sir,

I have read with great interest the advance copy of Load Unbalance on Single Phase Distribution Secondaries, and must congratulate you on the way you have handled the subject. This is quite a problem. Our experience has been that you have a good balance one week and go back a week or so later and find it all wrong. I certainly agree that the use of 220-volt on all ranges and heating appliances over 15 amperes would be the best way out, and a good balance would be had at all times. We always recommend 220-volt water heaters and wherever possible connect single phase motors 220-volt. I would prefer 220-volt ranges to the balance load switches.

The corrections of the five causes of unbalance as you show on page 254 are splendid. I only hope that it will become a standard practice in a very short time. While the balance switch on the range is an improvement, nevertheless I do not think it as good as your suggestions on page 254. I shall be anxiously waiting for the discussion news on this subject. I am,

Yours very truly,

(Sgd.) HERMAN DENEF,
Superintendent.

Paints and Painting

Practical Suggestions from the Experience of The Hydro-Electric Power Commission of Ontario

By T. H. Chisholm, Chemist and S. E. Craig, Testing Engineer, H. E. P. C. of Ont.

(Read before Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 9th, 1930

ONE is confronted with many problems in selecting paint. The requirements for one set of conditions may be entirely different from those for another. We are attempting here to give an outline of the general procedure followed by the Commission in testing and selecting paints for different uses, and to present some conclusions from our experience in this work, which we hope may be of interest and of practical assistance to the members of this Convention.

A paint may be defined as a mechanical mixture of solid materials, the pigment, and a liquid—the vehicle. In addition certain solutions of asphaltum and bituminous materials are also called paints.

Many special gums and oils are used in the manufacture of paints, and the technology of the subject is very complex. However, the average engineer is more interested in the service, appearance, and workability of the paint he requires, than in the special ingredients used. It is proposed, therefore, to discuss the former rather fully, and only refer to the ingredients where they have a particular bearing on the paint in question.

In many cases the most important function of a paint is to preserve for a maximum period the material upon which it is applied. In most instances, however, appearance must be considered together with service. In other cases, appearance becomes the important feature. The selection of a paint should, therefore, involve consideration of these points in addition to the exposure and the nature of the surface to be painted.

Two methods of purchasing paints are employed. One method is to issue Specifications for the various paints used, and purchase according to these Specifications. The other method is to purchase the paints developed by the paint manufacturers for the various purposes. Each of these methods has its particular advantages, but the Commission has so far used the latter because it is more adaptable where small quantities are purchased at any one time.

Paint Testing

The most common ways of testing paints are by exposure on panels, exposure on work, accelerated tests, and chemical analysis. The first two of these need no explanation. Accelerated tests are designed to reproduce service conditions as far as possible, but in a more severe manner, so that results can be obtained with-

General view of Painted Panels exposed on roof of Laboratory.

out waiting so long on the natural exposure. Chemical analysis is useful as a means of identification, and also gives useful information on the way the paint may be expected to act, but chemical analysis is hardly sufficient to warrant acceptance or rejection unless the paint tested is similar in all ways to paints which have previously been found satisfactory under exposure.

The procedure followed by the Commission in testing and selecting paints was planned some twelve years ago, and is still being followed. Paint manufacturers are requested to submit samples of paint that they would recommend for a particular surface and exposure, along with instructions for application. Certain chemical and physical tests are made principally for purposes of identification of future samples of the same brands of materials. The samples are then applied on suitable panels for exposure tests, and the exposed panels are examined from time to time to select those paints which will give the best service. From the data obtained after these years, a confidential list of approved paints has been prepared. The list is revised and enlarged once a year, so that the latest data may be included. By this practice, the engineers are supplied with a list of paints covering the majority of their requirements from which they can choose with assurance of reasonable service. The laboratory is always ready to receive new or improved brands, although they cannot be placed on the approved list until they have proven that they will give reasonable protection.

In addition, a little over a year ago, the laboratory installed a weatherometer for making accelerated tests on paints. As shown in the illustration, it consists of a cylinder 30 inches in diameter, with vertical slots on the inside into which test panels can be inserted. In the centre is a carbon arc lamp designed specially to emit rays similar to the destructive rays of the sun. In addition, a small stream of water is applied to one side of the cylinder. The cylinder is made to revolve once in thirty minutes and

the test panels are thus exposed to the action of the light from the arc, and they also pass through the water on each revolution.

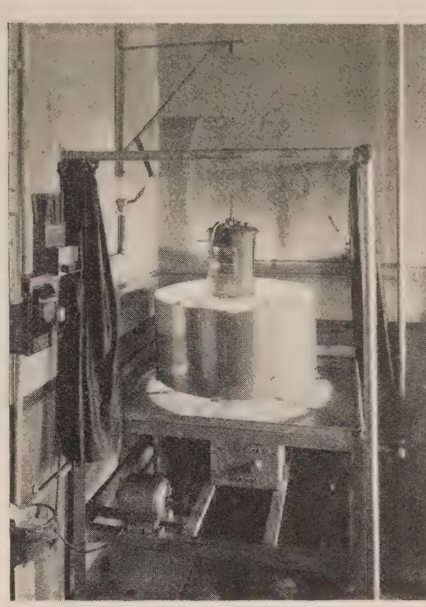
Similar machines are used by the United States Bureau of Standards, the Paint Manufacturers Association, and many paint manufacturers themselves, and we are well pleased with results to date. It is not considered that it does away with the necessity of making exposure tests, but it does reduce greatly the number of paints which would otherwise have to be exposed, as any paint which makes a very poor showing on the weather-ometer is considered unworthy of further attention. Our approved paints for exterior exposure will stand at least 3,000 hours in the weather-ometer while some inferior paints have failed at 200 hours. The paints that are used by the Commission are being constantly checked in the laboratory to see that they are the same as the original samples submitted, and the important structures are inspected at intervals to see if the field service obtained compares with our laboratory results.

The most important paints used by the Commission may be classed as follows :—

1. Structural Steel Paints.
2. Paints for Underwater Exposure.
3. Paints for Wood.
4. Paints for Concrete, Brick and Plaster.

Structural Steel Paints

It is recommended that new structural steel be given three coats of paint for outside exposures. The first or priming coat should be applied in the shop. It is preferable to apply the second or intermediate coat in the field after the steel has been erected, and the final coat should follow after the intermediate has dried. Structural steel for inside exposures, under ordinary conditions, is usually given only two coats, a priming shop coat and a final coat after erection.



General View of weather-ometer used at the H.E.P.C. Laboratory for accelerated weathering tests.

Where structural steel has to be repainted, the work will depend very largely on the condition of the existing paint. If the paint has failed and rusting and pitting have started, the rust should be completely removed, because any rust remaining, even if covered with new paint, will cause the rusting to continue. Very frequently only small patches of the first priming coat may be destroyed, and it is only necessary to cover such patches with a priming coat. Care must also be taken to see that no rust exists under paint which is only defective in small spots. Not

unusually these apparently small spots are found to be considerably enlarged next to the steel, and if not removed will cause the new paint to fall off. Under conditions such as described, it is necessary to paint as indicated for new steel after the rust has been completely removed. If investigation shows the original priming coat to be in good condition, it will be only necessary to remove the dirt and any loose paint, and apply the one or two field coats as may be desired.

Those of you who have had experience with repainting steel will appreciate the cost and difficulty of scraping and brushing the steel to properly remove the rust where the priming coat has failed. This expense will be saved if the priming coat is not allowed to fail, or if the repainting has been started before the failure has gone too far. In most cases, repainting is delayed too long.

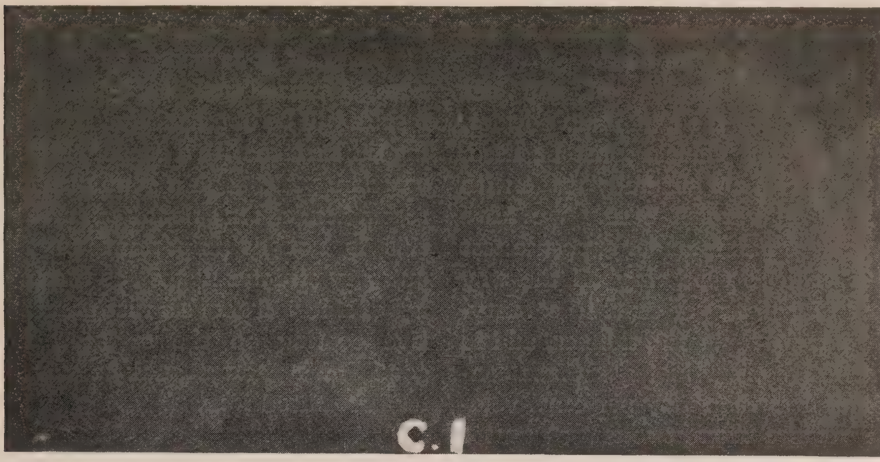
For new steel, the priming paint, or shop coat as it is often called, is, in our opinion, the most important, while in practice it is often given the least attention. Good results can only be obtained if the steel is free from all grease, rust and mill scale. Grease is removed by wiping with benzine, and in some cases sand blasting is used to remove mill scale. Care should be taken to see that the paint is brushed well into the surface. It may be necessary to apply the paint with a stiff brush by a circular motion to get it into the bottom of the pits. If paint is sprayed on, it is sometimes advisable to go over parts with a brush to insure that the paint has reached the bottom of any pits, and not bridged over them. Rivet heads need close inspection, as operators frequently apply the paint from one side only.

The pigments used in priming paints might be classed as rust-prohibitive, rust-stimulating, or inert. The rust prohibitive pigments are of a basic nature and those most commonly found in the better primers are: red lead, lead chromate, zinc chromate, and blue lead. These are usually combined with inert materials. The inert materials are usually asbestine, barytes, silica, clay, certain grades of iron oxide, and possibly certain natural graphites. The rust stimulative pigments are the carbonaceous materials, acid pigments or any materials which are electrolytically negative or cathodic with respect to iron.

It must also be remembered that the vehicle is as important as the pigment. Linseed and wood oils are the most commonly used, but soya bean oil, manhaden oil, and others may be used in combination vehicles.

Excellent results have been obtained with different brands of primers made with combination pigments and a good vehicle, but the standard red lead and linseed oil primer seems to be as good as any, and better than a great many of the so-called metal primers. A good red lead primer, if properly protected, can be repainted many times.

Certain objections are often advanced against a red lead paint. It is stated that such paints have poor spreading, are hard to brush, settle quickly from the vehicle, and on standing in a container for a short time will go ropy. General experience however, is that the better grades of red lead paint will cover between 700 and 800 square feet per gallon on a



Photograph of Paint Exposed on Roof of Laboratory. Red Lead next to metal. Graphite Finish Coat. Intermediate coat, equal parts of primer and finish. Condition is good after nine years exposure.

good surface, have fair brushing properties and will not go ropy unless they contain an excess of litharge. Such paints usually contain about five per cent. litharge and weigh twenty-nine to thirty-two pounds per gallon. While a small proportion of litharge is essential to red lead to give best service, too much will cause the paint to go ropy, and greatly increase the brushing difficulties.

For outside exposure, the second, or first field coat, is also very important, although at times it is omitted altogether. This coat may be called the reinforcing coat, and is often the same material as used for the finishing coat. Iron oxide has also been used extensively for this coat, and is quite suitable. Our tests, however, indicate that an excellent practice is to use a mixture consisting of equal parts of the primer and the finish paint. This practice seems to give a longer life to the job than using the finish paint for this service. It is quite customary to thin the first field coat with a little turpentine or turpentine substitute, in order to destroy a little of the oil gloss so that the next coat will bond to it.

A large number of paints are used as the finish coat, and in selecting these paints it must first be decided if maximum life or general appearance is desired. Where long life is the dominating feature, a good grade of natural graphite made into a paint with linseed oil containing not more than 20 per cent. by weight of volatile and drier in the vehicle, gives excellent service, and we have never tested any combination of paints, up to the present time, that gave as long a life on structural steel as a high grade red lead primer, a graphite finish paint, and an intermediate paint consisting of equal parts of the primer and finish paint.

The aluminum paints are becoming quite popular, and tests indicate that they will give excellent service and are about equal to the graphite paints as a protective coating, providing a good vehicle is used. We prefer purchasing the vehicle and powder

separately and mixing them at the time they are to be used.

A straight linseed oil will not properly carry the aluminum powder, and a special vehicle must be used. The vehicles are generally made with a long oil varnish base. We have aluminum paints under exposure test with vehicles that vary all the way from forty-four per cent. to seventy-two per cent. volatile thinner, and in practically every instance those containing less than fifty per cent. volatile require from two-and-a-quarter to two-and-a-half pounds of aluminum powder to make a satisfactory paint, although many paint firms recommend two pounds of powder. However, less powder may be used with the high volatile vehicles, but results are seldom as good.

In the early days of aluminum paint, it was advocated that this paint could be applied directly to the steel, but experience has shown that a good metal primer is advisable, and our present practice is to use the same primer that would be used for standard paints.

The aluminum paints reflect the heat rays from the sun, which makes them more desirable than the graphite paints for oil storage tanks. Tests show that on air-cooled transformers they retard the radiation of the heat generated in the transformer, and the temperature of the transformer will run slightly higher. Little, if any difference is obtained with the water-cooled transformers.

The painting of new galvanized iron may give trouble due to the paint flaking from the surface, regardless of the quality used. This trouble is usually overcome in practice by allowing the galvanizing to weather for six months or a year before it is painted. However, if it is necessary to paint new galvanized surfaces, we find good results will be obtained by first washing the surface with a copper sulphate solution. Although a good primer is recommended for galvanized surfaces, this is not as important as with ordinary structural steel, as the coating of zinc will act as a rust preventative coating on the surface. Any good finish paint should be suitable for galvanized iron.

Paints for Underwater Exposure

Paints for underwater exposure are now under test, but complete information is not yet available. Some thirty or forty different paints, recommended by manufacturers for protecting structural steel under water, were exposed on iron panels in the Niagara River. The paints consisted of asphalt preparations, bituminous materials, linseed oil paints, china wood oil paints, and vehicles made with a varnish base. Not more than ten per cent. of these paints proved to have any value for the purpose. In general, the linseed oil, china wood oil, and other varnish-base vehicles proved useless. However, very fair service was obtained with linseed oil and red lead paints prepared similarly to those used by the Union Pacific Railroad for interior of water tanks, the finish coat having ten per cent. litharge added to it at the time of application. The asphalt paints were not altogether satisfactory, but certain bituminous preparations gave fair protection. Very fair service was also obtained with a priming coat of red lead and a heavy finish coat of emulsified asphaltum. The emulsified asphalt was applied very thick (one

gallon spread over approximately seventy-five square feet.)

Paints for Wood

For the exterior painting of wood, the so-called standard formula paint appears to be as suitable as any. These paints consist of a pigment containing approximately seventy-five per cent. white lead and twenty-five per cent zinc oxide with the necessary tinting colours, in a vehicle of linseed oil that does not contain over twenty-five per cent. volatile material and drier. The percentage of lead will vary with the colour, and certain dark colours may not contain any lead. A small amount of a good spar varnish may be added to the paint to increase the lustre and give an enamel-like finish, but care must be taken not to add too much for, while an excess of varnish in the paint will produce a very pleasing finish, directly after it is applied, the life of the paint is shortened.

The priming of wood, as with steel, is very important if lasting results are to be obtained. We consider that white lead and linseed oil make the most suitable primer, and when prepared paints are used the white or light coloured paints are preferable, as they usually have the highest lead content. When the wood is old and open-grained, the paint is readily absorbed, and it should be thinned with linseed oil. When the surface is in fair condition, a mixture of linseed oil and turpentine appears to be the most suitable thinner. With new and close-grained wood, turpentine should be used to thin the paint, as it will penetrate the wood and carry some of the oil in with it.

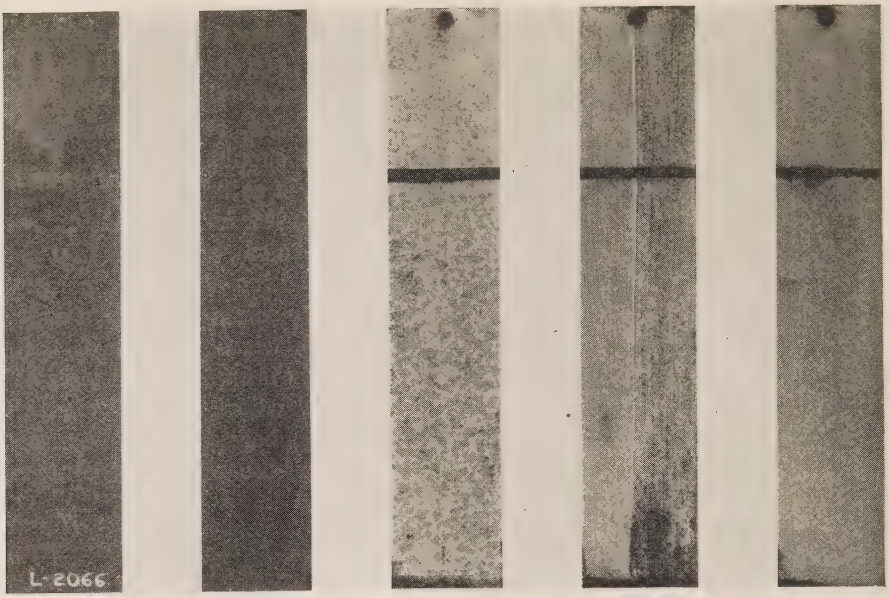
The natural gums in knots are likely to destroy the vehicle and cause brown spots to appear on the surface when painted with white or light coloured paint, and for this reason the knots should be sealed before applying the priming paint. Shellac is usually used for this purpose, but we have also obtained first-class results by using aluminum paint.

It is very important that a coat of paint has thorughly dried before another coat is applied, and cases have been noted where a paint failed due to checking, because one coat was not dry before the following coat was applied.

Paints for Brick, Concrete, Stucco and Plaster

In painting any of the above structures, the preparation of the surface should be given some attention. A good practice is to first apply a wash of zinc sulphate dissolved in water, in order that any free lime which may exist will be neutralized. Care must also be taken to see that moisture does not get in behind the painted surface, as it will destroy the paint.

The priming coat for this class of work is of the greatest importance. No doubt a great many failures of paints on such surfaces can be traced directly to improper penetration of the surface by the priming coat. Paint may be used which looks well, but which simply forms a smooth covering over the surface and does not penetrate. Such paints will have no bond to the surface, and will eventually flake off. Care should be taken to avoid this condition and to see that the priming coat properly penetrates the surface. This may not be easy, because the surface may



1 2 3 4 5

Photographs of some paints after exposure in Weather-ometer.

1.—Iron oxide primer after 500 hours. Complete failure.

2.—One of the approved primers after 2,000 hours in weather-ometer. Still in good condition.

3.—Aluminum paint over poor primer after 1,000 hours in weather-ometer. Shows failure.

4.—One half panel is aluminum paint over an approved primer; still in good condition. The other half is two coats of the same aluminum paint without a primer; complete failure. Exposure—1,600 hours.

5.—Same aluminum paint as No. 3, but applied over an approved primer, 2,000 hours exposure. Good condition.

not be uniform and the paint may strike in on some places, while it will not penetrate other places. The latter should be avoided under all conditions, and it would be advisable to use a paint sufficiently thin to penetrate the hard spots, even if the paint strikes in unduly in the porous places, making an extra finish coat necessary. If proper penetration is not being obtained, work should be stopped at once, and the paint altered to suit by small additions of turpentine, or turpentine and boiled linseed oil. The addition of too much linseed oil may retard the drying, but if drying is not affected too much, the addition of the linseed oil should be better than the addition of turpentine alone.

Some manufacturers claim that a wood oil vehicle is superior to linseed oil for priming paints for this class of work, but our experience and tests indicate that properly prepared linseed oil vehicles, without wood oil

or with some wood oil, will give as good service, and in some cases better service than vehicles made of wood oil alone.

Once the surface is properly primed, any paint that is suitable as a finish coat for structural steel or wood is also suitable for these surfaces. For concrete floors the life of the finish coat, providing the surface has been properly primed, will depend largely upon the vehicle, which is generally of the varnish type tempered with gums or resins.

It is frequently desirable to avoid a high gloss finish on stucco or brick. A number of semi-gloss paints are specially prepared for this purpose. They usually contain a prepared vehicle consisting of bodied linseed oil and wood oil with a volatile thinner added to obtain the proper brushing consistency. These paints give very good service, but it is our opinion that they are not quite as serviceable for outside exposures as the better grades of gloss paints. They make ideal primers however.

For interior painting, appearance is generally the important feature, and interior surfaces will usually have to be repainted on account of dirt before the paint itself has failed. On this account, paints for interior exposure are entirely different from those for exterior exposure. White lead is seldom used, but the pigments are mostly lithopone and zinc oxide. The vehicles are usually of the varnish type as these produce a better appearance.

Interior paints are supplied in whites and colours. The white paints have a tendency to turn yellow, especially the white gloss paints, and this should be borne in mind when making purchases. Very often a light tinted paint can be used in place of white, and will be found much more serviceable.

In addition, interior paints are supplied in three finishes—gloss, semi-gloss and flat. The gloss paints are usually much more serviceable than the flat paints, because they catch less dirt and wash much better. The semi-gloss paints are better in these respects than the flat paints, and may often be used when the gloss paints are not desired, and the flat paints are not essential.

Paint Failures

Paint will fail in different ways, but the most common forms of failure are flaking, checking, alligatoring, and chalking.

Flaking may be due to several causes. The paint may not be sufficiently elastic to stand expansion and contraction. It is more frequently due, however, to improper priming of the original surface. Paint defective in this manner should be removed before any attempts are made to repaint.

Checking is characterized by fine hair cracks, and is usually due to the vehicle being unsuited for the service. Paint in this condition should also be removed before repainting is attempted.

Alligatoring is due to the paint film being softened and drawn together in places, leaving thin veins between the heavy portions. These veins are weak and will eventually break through. This kind of failure is most common with bituminous paints exposed to sunlight. No general rule can be given regarding repainting of such surfaces.

Chalking or dusting is the natural way for paints to fail if all conditions are right, and all good paints properly applied should fail in this manner. Failure, however, will be accelerated by the use of inferior ingredients. This class of failure is due to the vehicle at the surface of the film breaking down, and there is nothing left to bind the pigment and it becomes loose and can be dusted off. Paints which fail in this way leave a good surface for repainting, and it is only necessary to brush or dust off the loose material on the outside.

Conclusion

In conclusion, some suggestions may be offered concerning the purchase of paints.

There is very little which is secret concerning either the ingredients, or the art of manufacturing of most of the paints that have been described. It will be found that paints of a standard quality for any particular use, are usually made from similar materials, and although the manufacturers will use different trade names, their products and prices will be very much alike. It is therefore likely that the cheaper brands will be of inferior quality.

On the other hand. the purchaser is often urged to buy some special and high priced paint. The laboratory never recommends the purchase of such a paint for either special or ordinary work, without investigation, and our tests on such paints have usually been disappointing. In many cases, it has been found that they are no better than the standard grades, and in some cases, not as good.

Those not fully acquainted with paints might be well advised to purchase the standard grades of paint recommended by reliable manufacturers for the particular work, and the best service should not be expected unless a fair price is paid.

Discussion

Mr. W. P. Dobson, H.E.P.C. of Ont.:

Mr. Chairman,—I would like to say a few words supplementary to Mr. Chisholm's paper and tying it in with the rest of the laboratory work. Mr. Chisholm's paper on paints is an illustration of the service the Commission has been trying to give to the municipalities, which service we are very glad you have so thoroughly appreciated, as indicated by Mr. Buchanan's resolution which was unanimously passed last year.

The matter of laboratory work, testing, inspection and research is something which from our experience in the work during the last fifteen years is of slow growth. It depends upon co-operation between laboratory and field. Taking paint as an illustration, paint was formerly purchased by individuals all over the system. Perhaps twenty, thirty or forty different men were purchasing paint for their own purposes, and these men had no data to guide them in purchasing. The result was that they were purchasing different brands of paint, which, in their opinion, were the best for their purposes. Now in some cases that worked out all right, but in general it did not, because the paints varied a good deal in their composition, and it was difficult to

judge between different brands. So we began the study of paint as a help to our engineering departments. We began in a small way, and it has grown to the magnitude which has been described by Mr. Chisholm today. The object is to procure the best materials possible for the services for which they are required, and the only way to do it in my opinion is to have the engineering department, the field, and the manufacturers and the laboratory, all working together. I am very glad to say that everybody is working together. When the man in the field wants a paint now, he specifies the service it is required for instead of specifying the brand of paint. The manufacturers have given their whole-hearted support to this work, and have shown that they are anxious to work with the Commission in producing a paint of proper quality. The same holds for other materials, such as steel and all kinds of structural materials, transformer oil, etc. The work can be extended with the co-operation of the municipalities, the Commission's engineering staff and the manufacturers. I hope this paper has been of sufficient interest to impress the one point on your mind that we stand ready to help the municipalities in the operation of their systems in securing the best material and the best equipment it is possible to obtain.

Mr. E. V. Buchanan, London :

Mr. President, I would like to ask Mr. Dobson if the same service can be rendered to the municipalities that is now rendered to the different departments of the Hydro-Electric Power Commission. I am sure that all municipal men have been pestered by different paint agents calling on them, telling them that this particular paint is the very best paint for the purpose and usually substantiating their statements by submitting testimonials from the Chief Engineer of the Canadian National Railway or the Canadian Pacific Railway and all the big organizations in the country, so that we don't know quite where we are at. I was wondering if we could submit our requirements to the purchasing department of the Commission and if that department, in consultation with the laboratory, would purchase the paint for us. It might be necessary, perhaps, in the case of municipalities, to give some consideration to local manufacturers, other things being equal.

Mr. Dobson :

Mr. Chairman, at the present time, as Mr. Chisholm has explained, a good deal of the information that has gone out is of a confidential nature. We have a system of reports prepared for the engineering department, listing certain brands of paint for certain service. I do not see why that information cannot be made available to the municipalities in the way of recommendations and we will certainly be glad to undertake any investigation or research work on new paints or new requirements for paints for different kinds of services which have not already been studied.

Mr. A. B. Scott, Galt :

Mr. President, like a number of others here, we handle the work of the water department as well as the electrical department in our municipality, and our problem in Galt is to get a paint that will stand up on the inside of a stand pipe. We have a

standpipe which has been giving service for probably thirty-five years, and I think for perhaps twenty-five years no effort was made to preserve the interior of it. Recently, however, we have been trying to get a paint which would stand up under the conditions we have there, but so far without very much success. I am sure that we would appreciate any recommendation that we could have from Mr. Chisholm, or Mr. Dobson's department, as to a paint that would give us service.

Mr. Chisholm :

That is one of the things that has given us more trouble than anything else—namely, the inside of a water tank. We are working on it, and have been for three and a half years. We have some sixty paints. The majority of them the manufacturers strongly recommend for iron directly under water, which would be the same as the inside of a water tank. We have not yet found one which we think is really satisfactory. Of course, you have to take into consideration whether the water is for drinking purposes, or general domestic use, and we have not been following any tests for drinking purposes only. Some of the paints we have found very good, but I would not recommend that they be put into water pipes that are to be used for domestic purposes. I will be only too glad to get out whatever data we have on that, and send it to anyone. Another thing, you must remember in painting structural steel, if you are after maximum appearance, you cannot get maximum protection. About three years is the average life of paint which looks good, and keeps good; at least, we have not found them last any longer. But if maximum protection is the thing you want, and appearance is only a secondary consideration, I don't see any reason why you cannot get for general structural steel at least seven years' use if properly painted.

Chairman :

Perhaps Mr. Chisholm might give us a word on what he considers the advisability of spraying or brushing.

Mr. Chisholm :

I had a little experience in that with the men in the field. I have found out that spraying, in a good many cases, is not as good as brushing. Now I don't know whether that is due to the spray, or due to the care with which it is put on, but if you have a pit hole in a tank, say an eighth of an inch deep, and a man comes along with a spray, there will be a probabability that it will be bridged over, leaving a small cavity with air in it. After the paint has been on for about a year, the bridge will break through and corrosion will set in. If it is cleaned well and brushed, using a circular motion the paint will flow into those cavities. We have records of quite a few failures where we have used both the spray and the gun. I went out five years ago with two gangs for a couple of weeks. We did several experimental jobs, both spraying and brushing, and the brushing certainly was away ahead of the spraying. Mr. Acres has taken the stand at the foundry where he gets structural steel sprayed that, after the steel is sprayed, he well have a man go right over the ragged edges of the steel with a brush. We are getting good protection by doing that,

and I think we have been well paid by having that work done.

Mr. R. H. Starr, Orillia :

Might I ask, if you have had any experience with paints, using as a base what is called china wood oil ?

Mr. Chisholm :

China wood oil has a tendency to check and, if it has a high oil content, 90 per cent., it will check. Another thing, china wood cannot be used in its raw state. It is cooked with a gum and the gum is mostly a resin. We have found, by using the resin with the china wood paint, that it has a very highly glazed finish. It has a better waterproof film than linseed oil, but is liable to check. Personally, if you want an enamel finish for inside work, china wood oil is excellent, and our experience has been that it is very much superior to linseed oil for outside exposure. China wood oil, where you want appearance, is one of the best you can get, if appearance is the dominant feature.

Mr. E. R. Lawler, H.E.P.C., Ont.:

I would like to ask Mr. Chisholm if he has had experience with a machine which sprays moulten metal on the article to be painted, and what the life of that class of work would be.

Mr. Chisholm :

We have had no experience with that whatever. We did get in touch with the firm who manufactured it, and wrote them, to get details of their system and all about it. They wrote back and gave us a tract telling us what their machine would do. I wrote back again and asked them if they would submit us samples of iron treated with zinc, and one or two others we were interested in that we thought might be of some value. In answering the letter they gave us to understand that, while they would recommend it, they couldn't submit any sample, so I have discarded it until such time as they will submit samples.

Mr. Scott :

Mr. Chisholm, do you suppose that the atmospheric action on a tank would have anything to do with the corrosion on the interior ? That is, during the winter months, the water immediately in contact with the interior of the tank keeps the side of the tank at a higher temperature than the part that is not covered by water, and, in the summer time, the reverse condition exists. Would you suppose by having the tank painted aluminum, as you spoke of, or some other light colour, there would be a tendency to throw off the heat rays and preserve the interior of the tank ?

Mr. Chisholm :

I am afraid I cannot answer your question. It is a good point, and one well worth looking into.

Mr. R. H. Martindale, Sudbury :

I think, Mr. Chairman, possibly part of Mr. Scott's trouble is due to ice formation in the tank. Our experience with water pipes is from the formation of ice on the surface, and around the steel shell. When the ice loosens in the spring and starts to move, due to changes in the height of the water in the tank, it has been our experience that that ice scrapes or sheers off the surface on the interior of the tank.

Mr. Scott :

I don't think our condition would be just the same as Mr. Martindale's, as we don't have any formation of ice in our tank. The level of the water

changes quite frequently every twenty-four hours.

Mr. Chisholm :

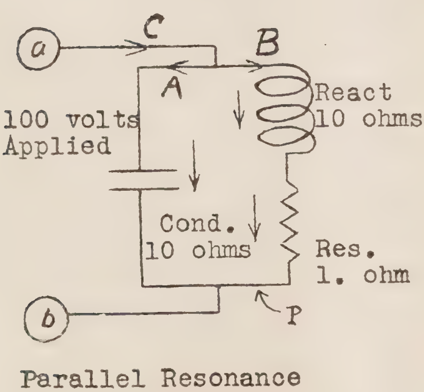
We have had some panels exposed in the Niagara River. About a foot at the top is out of water, and there is about eighteen inches of the upper part where the water varies from day to day. The balance of the panel is always under water. No ice forms around these panels. We find the area where the water level varies is the hardest spot to protect. That is always the first spot that goes. The asphalt paints above water in the very humid atmosphere seem to give pretty good service, but they are completely gone at the water line. Below the line, they are only fair. The bituminous paints under water were the reverse, and were better than the portion above water, but the piece between where the water level varies was always the first to go. We didn't get very much difference with the under water and right above water set of panels with coal tar paint.

Practical Use of Vectors in Electrical Work

By H. S. Baker, Meter Engineer, H.E.P.C. of Ont.

Continued from June Number

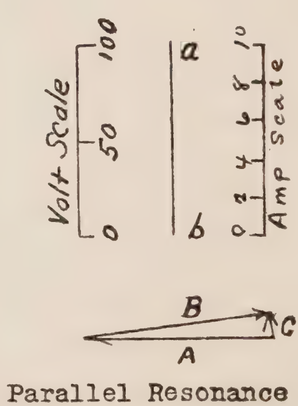
FIG. 47
SPACE



47. Parallel Resonance

Fig. 47 shows the space data of the parallel circuits, and the reactance and condenser have the same values of impedance as expressed in ohms. Under heading 45 we plotted the right hand branch of Fig. 47. The results (using the values given in Fig. 47) would be that the current B is 9.95 amperes, lagging (a—b) by the angle whose tangent is 10.0. Similarly referring to heading 44 we

FIG. 48
TIME.



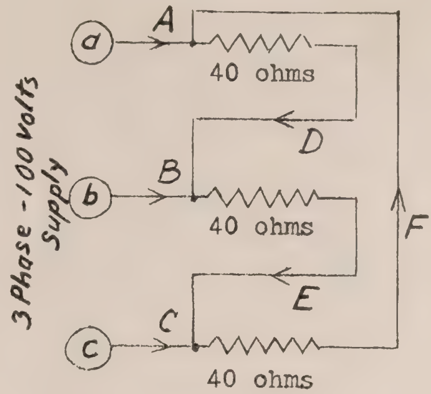
find that the current A is 10 amperes leading (a—b) by 90 degrees.

In Fig. 48 we have plotted (a—b) and A, and B, and the vector sum of A and B which is C. We see that the input current C is only 0.995 of an ampere, and hence the total impedance of the system is 100/0.995 or 100.5 ohms, which appears at first sight to be too high for the parallel circuits of about 10 ohms each.

If the ohmic resistance of one ohm could have been reduced to zero, then the total impedance would have gone to infinity. The high value of impedance is however dependent on the applied frequency being such as to hold the balance between the impedance values in ohms of the reactance and the condenser.

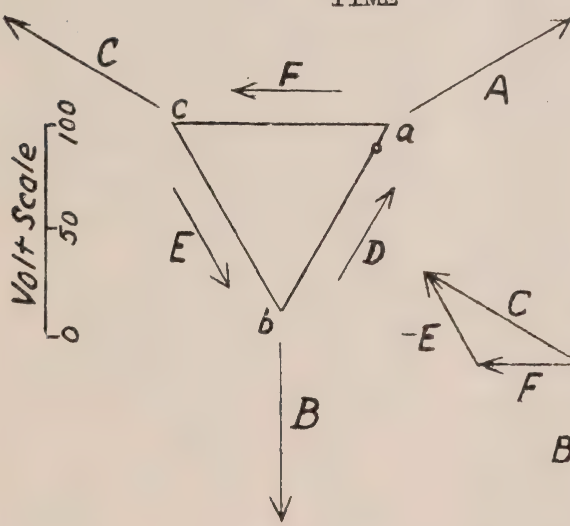
In a radio tuned circuit, the voltage supply is not connected directly to the points a and c, but is applied to another coil whose field induces voltage into the reactance.

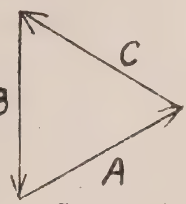
FIG. 49
SPACE



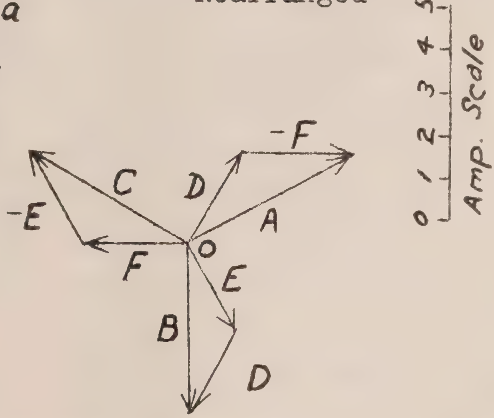
Ohmic Balanced Load

FIG. 50
TIME



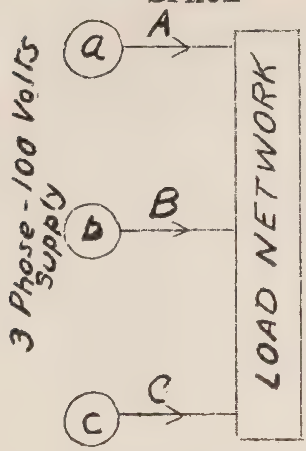


Current Vectors Rearranged



Current Vectors Combined

FIG. 51
SPACE



Unbalanced Load

In the above network Fig. 47 we have an apparent contradiction in that we can greatly decrease the total impedance from a to b by breaking a connection in the network. The connection may be anywhere in either branch of the circuit. For instance if we opened up at the point P, we would decrease the total impedance from 100.5 ohms to 10. ohms.

48. Balanced Ohmic Three Phase Load

Fig. 49 shows a balanced, delta connected, three phase load, of three 40 ohm, ohmic resistances. Since the load is entirely ohmic, we may take it as of unity power-factor, and we will see where the current vectors lie.

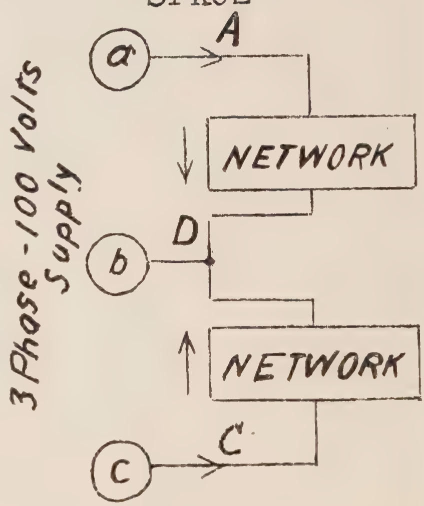
The voltage supply is represented by the triangle a, b, c, Fig. 50. The three currents D, E, and F are shown as the three detached vectors D, E, and F parallel to the three voltage differences (a−b), (b−c) and (c−a).

The current vector A is made up of plus D and minus F and these are shown added together to make A. Similarly B is plus E and minus D, C is plus F and minus E.

If now we should move the centre O of the ampere vector diagram to the centre of the voltage diagram, then the three ampere vectors, A, B, and C would point directly out of the corners of the voltage triangle a, b, c. This is the unity power factor position of the ampere vectors. For balanced loads of other power-factors, the ampere vectors would lag from the above three positions by an angle which is the lag angle of the balanced load.

The vectors D, E, and F are 100/40 or 2.5 amperes long. The vectors A, B, and C then scale to be 4.33 amperes long.

FIG. 52
SPACE



Equivalent Unbalanced Load

The watts in one resistance is 100 volts, times 2.5 amperes or 250 watts.

The total watts then are 750.

This is seen to be the amperes in one leg (4.33), times the volts between legs (100) times the square root of three.

Since this is a unity power-factor load the total volt amperes are also 750.

A balanced load of any power-factor but of these same ampere and volt values, would have the same volt-amperes.

Then for balanced three phase loads of any power-factor, the volt-amperes are the volts, times the amperes, times the square root of three.

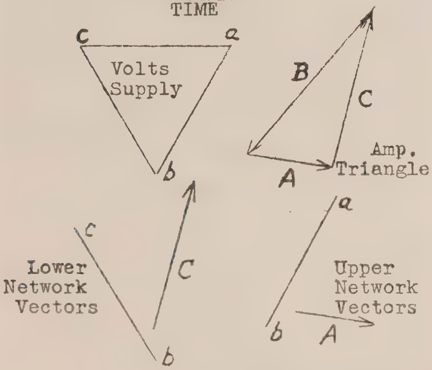
49. Unbalanced Three Phase Load

Fig. 51 shows a three phase voltage, balanced or unbalanced, feeding into an unknown network.

The currents from the terminals A, B, and C are shown as unbalanced in Fig. 53.

Fig. 52 shows a network between a and b which is adjusted to produce the same ampere vector A as in Fig. 51. The same thing is done with the other network to produce the same

FIG. 53



Unbalanced Load

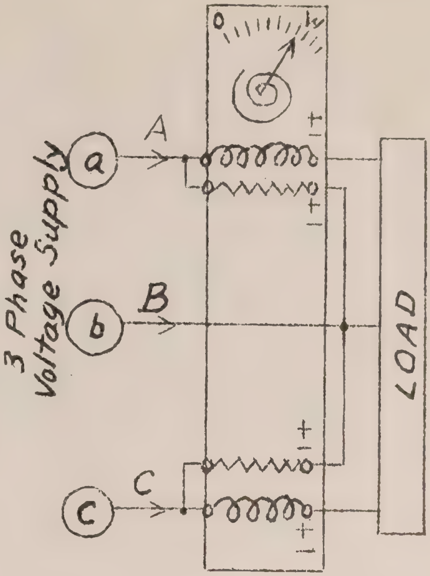


FIG. 53A
Polyphase Wattmeter

ampere vector C as shown Fig. 51. Now since A and B are the same in Fig. 52 as in Fig. 51, and since A plus B plus C is zero in both cases, then the B amperes are alike in the two cases, and the conditions of amperes, volts, watts and power-factor are the same at the terminals in both cases.

50. Polyphase Wattmeter

If we connect a wattmeter Fig. 53A with its current coil fed from A, and its voltage circuit fed from (a—b), it measures the watts of the upper network in Fig. 52. Similarly a wattmeter with C amperes and (c—b) would measure the watts in the lower network. If now the movements of the two wattmeters are mounted on one shaft and made to wind up one spring and deflect one pointer, the result is a polyphase wattmeter measuring the total load represented by the three amperages A, B, and C

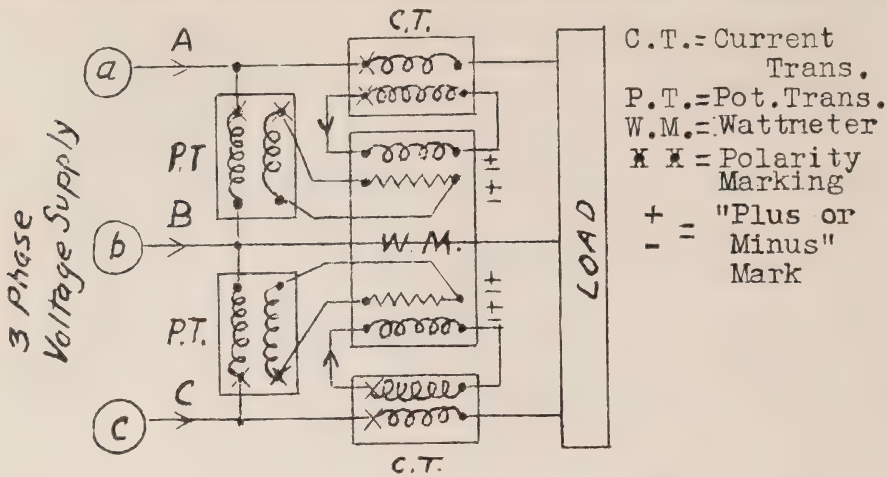


FIG. 54
Polyphase W.M. with P.T. and C.T.

in either Fig. 52 or 51. These connections are known as standard three phase wattmeter connections and are shown in Fig. 53A without instrument transformers and in Fig. 54 with them.

Note the polarity markings and ampere space arrows, which bring primary and secondary current transformer ampere vectors in step. Notice also in Fig. 53A and 54 the meter polarity markings to get plus deflection on meter.

51. Polyphase Power-Factor

The definition of power factor as the ratio of watts to total volt-amperes seems to be practical of application to single phase circuits and to polyphase loads fed from balanced voltages, even though the loads may be unbalanced.

As soon as we combine unbalanced volts with unbalanced amperes, then the difficulty arises as to what voltages to multiply with what amperages to get the various quantities to make up the total volt-amperes.

Even where the above definition is thinkable as applied to polyphase loads it is very difficult to meter.

The following definition agrees with the above for sinusoidal currents and voltages in all cases except unbalanced volts combined with unbalanced amperes and actually forms the basis of power-factor and volt-ampere measurement in at least three different practical systems of metering.

The total volt-amperes is first defined as the hypotenuse of the right angled triangle whose two other sides are the total watts and the total reactive volt amperes.

The power-factor is then defined as before as the ratio of the total watts to the total volt-amperes.

The practical application of this definition then depends only on measurement of watts and of reactive volt-amperes. Both of these are practical as wattmeter elements can be connected to register either watts or reactive volt-amperes, and no am-

pere or voltage measurements are necessary.

For many years the relation between power-factor and the ratio of the readings of the two halves of a polyphase wattmeter, has been known.

This applies only to balanced three phase loads and is as follows:—

$$P\ F = \frac{R+1}{2\sqrt{R^2 - R + 1}}$$

where R is the ratio of the readings.

In Fig. 50 for unity power factor the one element of the wattmeter receives the current A and the voltage (a−b). This is a lag of 30 degrees on that element. On the other element are C and (c−a). This is a lead of 30 degrees. Now as A and C begin to lag around to the right as the power factor decreases we have A, getting more out of step with (a−b) and reducing the reading on that element, while C is coming more into step with (c−b) and increasing the reading of the other element. Thus the ratio of readings (which is unity for unity power-factor) changes when the power factor changes and follows the law given above.

About 15 years ago the writer developed a similar formula which is applicable to unbalanced loads. It involves four wattmeter readings which we will call R, L, RL, and LR. The R and the L are the single element readings which involve A(a−b) and C(c−b). The RL and LR are A(c−b) and C(a−b). These are quickly taken on a graphic meter with its zero temporarily raised, by applying the potentials, one at a time, in their proper places and reading R and L, then apply the potentials interchanged one at a time and read RL and LR.

The formula is:—

tangent of lag angle

$$= \frac{(R-L) - 2(RL-LR)}{\sqrt{3}\ (R+L)}$$

This applies to all unbalanced loads, even to single phase loads tapped through a polyphase wattmeter from a polyphase voltage. The derivation of this formula will not be given at this time.

The above four readings are taken at regular intervals on customers' loads, and they form a regular check on the customers' power-factor even if no other meters than wattmeters are installed. These four readings give the data for the plotting of the ampere vectors of the customers' load as delivered to his meter, and when plotted at regular intervals give a guarantee of the continued

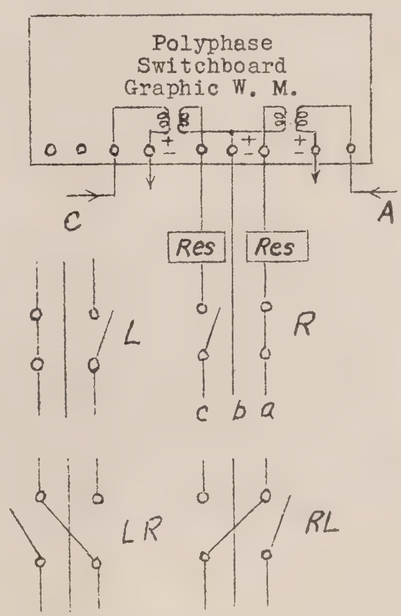
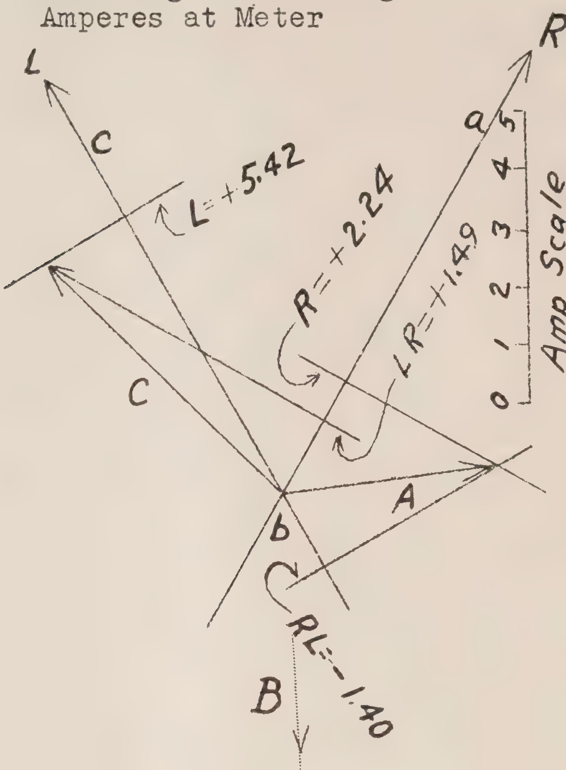


FIG. 55
Zero Switch connections
For "R and L" Readings.

FIG. 56
Plotting of existing
Amperes at Meter



correctness and continued completeness of the connections to the meter. They also show the amount of unbalance in the amperes.

A specific case will be plotted to illustrate the routine. The readings in a typical case would be taken as shown Fig. 55 by manipulating the connections as shown at the potential "zero switch" of the wattmeter. The meter zero was raised on the scale before taking the readings by placing a small temporary weight on the meter balance element.

This raising of the meter zero is done so as to be able to get the negative reading shown below. The voltage at the meter was 107 balanced, and the "R and L" readings in watts, as taken, and in "in step" ampere components, were —

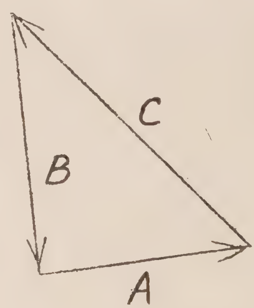


FIG. 57

Finding B
from A and C

R is plus 240 watts or plus 2.24 amperes, as component of A along (a—b).

L is plus 580 watts or plus 5.42 amperes, as component of C along (c—b).

RL is minus 150 watts or minus 1.40 amperes, as component of A along (c—b).

LR is plus 160 watts or plus 1.49 amperes, as component of C along (a—b).

Fig. 56 shows the plotting of the A and C ampere vectors from the ampere component values.

The B vector is determined in Fig. 57 by combining A and C. The value of A, B, and C in amperes, when measured on the diagram are 3.6, 4.6, and 5.7. This shows the degree of unbalance of the customers' amperes.

Since the tangent of the angle of lag is the kw. divided by the reactive kv—a. then the reactive kv—a. is the tangent times the kw. But the kw. is (R+L) then the reactive kv—a. is

$$\frac{(R-L)-2(RL-LR)}{\sqrt{3}}$$

The above formulae are of course for standard wattmeter connections measuring unbalanced, or balanced power, in three wire, three phase circuits. If however the R and L readings are taken on a four wire three phase meter (using two current coils) by manipulating the connections at the zero switch as before, then the tangent formula has a plus instead of a minus before the 2 in the numerator.

Should any marked trouble develop in the metering system, either in the metering transformers, or the wiring, or the meter itself, then the above monthly plotting of the ampere vectors, as found, will show up that something is wrong, and will in general show up what is wrong.

These periodic tests, of four readings each, keep the power company in touch with the customers' ampere unbalance, power-factor, and condition of the metering system.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Some Phases of General Office Administration

By W. E. Wallace, Office Manager, Windsor Hydro-Electric System

(Introduction of Discussion at Accounting and Administration Session of Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka July 8 1930)

ONE of the many important functions in Public Utilities or Central Station administration is the matter of Credit and Collections. Especially is this so in the office where Merchandising is carried on, and we know of no Department that can make and help hold the friendship of good customers more so than the Credit and Collection Dept., they by judicious credit granting and sane collection methods make for sound and pleasant public relations. But it is a case of at all times being eternally on the job gathering information and following up to prevent if at all possible, losses through lost addresses, etc.

In connection with credit granting to customers purchasing merchandise, we find that in some cases it is better to leave appliances in the stock-room rather than sell them on time payments. When a salesman has a buyer for any major appliance, he must place the contract in the Credit Dept.'s hands while the customer is still in the shop in order that there may be no misunderstanding, for in some instances it is found that the purchaser is unworthy of credit, thus it is the unpleasant task or duty of the credit man to explain to the purchaser just why the credit cannot be granted.

Possibly you question whether we aie justified in this action, but when you realize that we have open to us the data gathered by our own Local Credit Bureau, which is owned and operated by the reputable business men of the city, added to which we

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have the information gained from our files covering many years, one can readily understand that all of this particular purchaser's credit purchases are listed in the files of the Bureau and in this way we can get a very true picture of their ability and willingness to pay.

There has rarely ever existed a time when greater need for preliminary credit investigation was so essential as you will find from present day conditions. Many customers formerly considered good, or at least satisfactory, have slipped in a credit way. There is a tendency on the part of the customer public to pyramid their accounts, and then also you are faced with considerable unemployment. Any of these are good and sufficient reasons for checking up on all credit customers whom we find slowing up.

It is not only the old customers who show a tendency to freeze up your accounts receivable or capital, but it may be your new accounts. It is folly to open new accounts without ascertaining their credit standing, because they may be overloaded elsewhere.

* * * *

Mr. McAuley, H.E.P.C., advocated stricter measures in collecting light and power accounts, and advocated a follow-up system for transients going from one municipality to another, leaving accounts. He also advocated a standard deposit in all municipalities. Mr. Johnston, of Etobicoke Township, said "We use a form of application which requires the applicant to give his former address when applying for service." Mr. Heise, of Preston, approved of Mr. Johnston's method, and thought it would be of help in taking care of delinquents. Mr. Pritchard, of Chatham, recommended more hearty co-operation among the municipalities in the collection of accounts, in cases where consumers had left a municipality owing a bill. He also stated that they have little trouble in collections of merchandise department as they check the records of their prospective purchasers on their lighting accounts. Mr. Pritchard also favoured considerable leniency in cutting off for arrears, only using it as a last resort. Mr. McAuley advocated the cutting off after a second notice if no attention had been paid to the same. Mr. P. B. Yates, St. Catharines, stated that they allowed leniency where customers made an effort to pay, but notified delinquents from other municipalities that the service would be discontinued if such accounts were not paid. Mr. Yates stated that they did not require deposits excepting in cases where customers were

moving into furnished apartments. Mr. Johnston, of Etobicoke Township, stated that if a consumer's service had been cut twice for non-payment they required a deposit before re-connecting the second time, and stated that they charged $1.00 for either collection or re-connection. Mr. Jackson, of North York, stated that they found that in rural areas where bills are delivered it cost too much to deliver cut-off notices. Mr. McAuley, H.E.P.C., stated he did not consider the employment of collectors good business, but thought it was up to the consumer to come to the office to pay his bill. Mr. Heise, of Preston, asked if it was the custom to disconnect services where premises are vacated, and was answered by Mr. McColl, of Walkerville, that their practice was to disconnect all properties when vacated, but that no charge was made for re-connecting. Mr. MacKenzie, of East York, asked what procedure was followed when a service had been disconnected for an old tenant who was delinquent, when the property was occupied by a new tenant. Mr. McDonald, of the H.E.P.C., stated, that in his opinion, to a large extent the matter of collections depended upon the staff or management of the office, and he did not favour the employment of collectors. He stated that you could not refuse credit when the applicant met requirements. He did not favour deposits and did not consider that the Utilities had the right to ask the prospective customer what municipality he had come from. Mr. King, of Midland, wanted to know whether or not a Utility would be justified in refusing to sell merchandise to a customer whose ability to pay was in doubt. Mr. King stated that delinquents constituted a very small part of their customers and he thought an effort should be made to educate the slow payers by persuasive methods before cutting off. Where the service was discontinued, however, $1.00 was charged for cutting off and another $1.00 for re-connecting. Mr. Hanna, of the H.E.P.C., stated that when merchandising is being done it should be handled like any other retail business and stand on its own feet; therefore, it would not be good business to sell on time to those who were apparently unable to meet their obligations. When goods were sold on the instalment plan the ordinary precautions should be taken, such as lien agreements used in the sale of machinery by others. Nevertheless, as a last resort arrears on such accounts might be collected in the bills for electric service as for apparatus furnished to consumers.

Under the Public Utilities Act in force since June, 1927, landlords are not liable for arrears incurred by tenants; that is, the lien for arrears does not attach on the land or the landlord's interest therein, but only on the estate or interest of the consumer. Deposits from such consumers were a wise and necessary safeguard to the utility. Where tenants change frequently or there has been trouble on account of tenants' arrears it has been found useful to make the landlord the consumer and sign the contract as such, then there will be a lien on his land for arrears.

A new tenant is not responsible for a debt owing on a contract with a

former tenant. Still, the utility must have some say as to whom it has as consumers, and it has been found that a good deposit helps. However, it does seem rather extreme to require from a new tenant payment of a debt by a former tenant because the new tenant has little real chance of collecting.

After a contract is entered into with a consumer it might be held a breach of that contract to cut off service for the non-payment of a debt incurred in the municipality where a consumer formerly resided, but in almost every case the new customer will not wish to advertise to his new neighbours that he left debts behind him and will pay up rather than complain. In any case it is reasonable to make full inquiries from a new consumer before making a contract. The utility is entitled to know with whom they are to deal. The utility should be able to secure from the utility in the former municipality a record of the prospect and if this is not favourable take proper steps for protection by substantial deposit. No objection should be taken because full information is required by others, such as banks and credit associations, and electric service is sold on credit.

Some Advantages of Mechanical or Machine Billing of Consumers Accounts

By A. B. Manson, Manager, Public Utilities Commission, Stratford

(Introduction of discussion at Accounting and Administration session of Association of Municipal Electrical Utilities at Bigwin, Inn, Muskoka, July 9, 1930)

THE Stratford P. U. C. owns and operates four Departments — Electrical — Water Gas and Hydro Shop.

A couple of years ago the billing was done in our office entirely by hand, that is by filling in all blanks in longhand, with pen and ink. This, as you know, has limitations and drawbacks. In the first place it was slow, in the second place it was not always accurate, and finally it did not appear business-like. In a word, too much of the personal equation entered into the work. If the staff was in the pink and feeling well and the weather cheerful, few errors crept in, the penmanship was good and all was well, but blue Mondays will occur.

Our next step was when we dropped the longhand writing and took to the typewriter to make out the bills. This of course was subject to all the human weaknesses that the older method had except that the bill was a better looking job and always legible. There was the same difficulty with errors and no check except by the writer of the bill, and in the monotony of hundreds of accounts similar in

almost every respect it is no wonder that errors sometimes happened. There is nothing quite so pleasant to some customers as to be able to bring in an account and say there is an error—the stub does not correspond with the main bill, etc., etc., and there is nothing that maintains the prestige of a billing office with the public as freedom from errors.

About a year ago we began an intensive inquiry into Mechanical Billing, with the result that about Jan. 1st last, a machine was placed in operation. Unfortunately our Januarys in the past have been exceptionally busy with compiling records and winding up the year's business so that it was February or March before our machine got into actual operation with a trained operator.

The machine we use is a Burroughs of seventeen bank capacity and capable of setting up two commodities on the one bill. This was most satisfactory for us as we bill water and light on the one form, and gas on a separate one.

From our experience of a few months we have found an almost total elimination of errors, as whatever is set up on the machine once, goes right through, from the main bill to the stub, to the ledger card and recap. sheet. We have been using a recap. sheet of about thirty accounts each of electric and water, so that the operator proves her billing on an average of sixty accounts. Any errors are then checked up when the recap. is proved and before a bill leaves the office. The information secured on the recap. is, the present and previous readings, giving the total consumption, the service charges, charges at 1st rate and 2nd rate, the gross bill and the net bill. Having all this information totalled it is but the work of a minute or two to prove the sheet correct or otherwise, and if otherwise the correction must be made at once. It is gratifying to say that errors are exceptionally few when the operator has become proficient.

It is this totalling or recapitulation that is going to eliminate a lot of drudgery at the end of the year in securing all the information required by the H.E.P.C. for their annual report.

As mentioned before the absolute accuracy as between the customer's bill, the cashier's stub and the ledger card is one thing that is much to be desired. The legibility and neater appearance of the bill establishes confidence with the public and lastly a prompt and efficient system of billing is established.

With regard to operation we have one operator assigned to the machine, but two other billing clerks are familiar with the operation as understudies.

We might also say that under our present system we use just one-half the paper formerly used in bills. This reduces the cost both in paper and printing. The Addressograph is so arranged now that one impression is made as compared with two formerly. The two accounts, being on one bill, is a further convenience to the cashier, in taking money, and to the ledger keeper in making the entries and posting. A combination Electric and Water Cash Book is now being used which is a saving in paper and time in entering stubs as the one entry for

account number is sufficient and the amount paid is carried to the proper column. In place of one clerk entering Electric stubs and another clerk entering Water stubs each day, one clerk can now handle the job nicely in a very little extra time. In posting to the ledger cards we find it quite convenient to have both Electric and Water entries in one cash book.

Speed in billing was not the goal at which we aimed, as much as general efficiency, but it might be interesting to know that with the few months' experience we have had, our chief operator now regularly runs an average of one account every twenty seconds, inclusive of time required to prove the recap. sheet. Needless to say very few errors creep in on her run. As a matter of actual count this operator is averaging one error to every five hundred accounts.

We believe also that machine billing is of a very definite value and assistance to the Audit Dept. as well as to the Billing Office and the public in general.

Our Billing Office was asked the question : "Would you like to revert to the old system of billing ?" and the answer was a decided "No !"

* * * *

The discussion on this paper brought out the fact that with the aid of billing machines more accuracy in the records, more legible records and a great deal of statistical information is attained, and these advantages are sought ahead of speed in billing, although it has been found that billing is speeded up.

The Operation of Control Accounts in Respect to Consumers Accounts Receivable

By A. D. Nelson, Accountant, Kingston Public Utilities Commission

(*Introduction of discussion at Accounting and Administration session of Association of Municipal Utilities at Bigwin Inn, Muskoka, July 9th, 1930*)

IN August last year two gentlemen called at the office of the Kingston Utilities and after watching the sure strokes of the Burrough's Billing Machine for a while interested themselves in the ledger balances arriving under the Control scheme set up by the Hydro auditors earlier in the year.

A few days later the General Manager at Kingston received a letter which in part read as follows : "Mr. Hillman and I wish to express our appreciation of the courtesies extended to us yesterday by your staff, and I wish to add that at no time during the many years I have been visiting your office, have I found the work in such good shape. The billing machine is working fully as well as we could expect, and the feeling of confusion and uncertainty

on the part of the staff has entirely disappeared and I am glad to offer my congratulations." Signed, R. C. McCollum. That is an endorsement of Consumers' Accounts Control which demands respect. Remembering Mr. McCollum we share Barrie's thought that "memory was given so that we might have roses in December."

Kingston charges Electric Light and Gas on the one bill, and the billing is printed at the same time on the ledger cards. The Burroughs billing machine was installed in October, 1928, but the control work had not commenced when I took charge as accountant in February, 1929.

I tried to work back to the first of the year, but could not find a sure starting point, so with the sanction and help of the Hydro auditors we began as from April 1st, 1929.

Right from the start we began to balance very closely, and every time the Hydro auditors paid us a visit they gave us great help in making the staff realize the bookkeeping significance of all entries made, and the benefit in time-saving of correct work. In the last three months in thirty ledgers or divisions in Electric Light and Gas we have not been out of balance in accumulated differences more than $5.00.

The economic value of the Control is well instanced in the fact that exact knowledge of bad debt loss is known. Without control, there is no sure information, nor precautionary information of loss by error, whether deliberate or careless, in consumers' accounts. The balances drawn up as Accounts Receivable in our office at the close of 1928 entered on the balance sheet were hundreds of dollars astray as my attempt at backdating the Control brought to light.

With the Burroughs machine we are operating with two less on the staff than before the control was begun. The machine with one operator does in about five and a half hours, work which has on occasion taken three persons about seven hours to cover and then without the totals which the machine gives in consumption, service charge and gross and net daily accumulations.

We could assume an annual depreciation charge of 20 per cent on the cost of the billing machine if considered as equally owned by Light and Gas Departments, and still save in wages as compared with former expenses incurred about $750.00 annually.

Control statistics, because of reliability, are particularly serviceable when changes in rates are pending, and in making monthly comparison through the year and between periods.

The Control indicates the total charges for consumption and service which should be made, and in balancing gives proof that these totals are on the books.

In respect of collections, the Control provides an authentic dun sheet, the age of the arrears being easily entered when the balances are being written.

These ledger balances which form the dun sheet, represent the difference between the debits and credits arriving within the balancing period plus arrears unpaid, and are thus entered on the bills sent to consumers, who, in their acceptance, verify that the

balances are correct and that the cashier has credited all that has been paid.

The first step in the Control is the meter-reading. We require the meter readers who also deliver the bills to give a list every morning in name and address of all the readings they have failed to make during the preceding day and the reason therefor. These missed readings are picked up by themselves within a few days or are read specially.

We have found these non-readings figure largely in the accumulation of arrears.

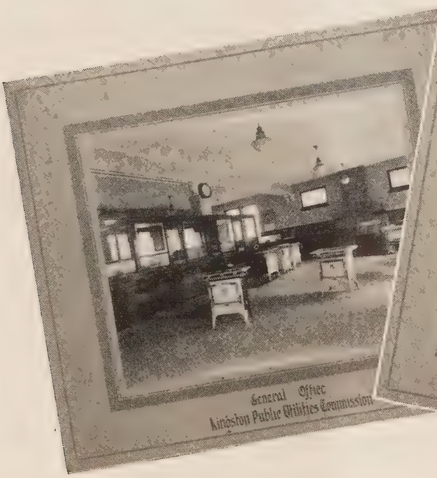
The ledgers being in balance, the ledger card of a delinquent tells the true story.

In conclusion I should like to thank the Hydro auditors for their very friendly and capable interest. It has certainly paid Kingston to co-operate with them, and there is always the Burroughs Adding Machine Company with their reliable mechanical basis in billing and proving up. A properly set up Control in its clearness helps beyond all doubt to foster the co-operative spirit which makes work a pleasure, bringing together employer and employee, producer and consumer.

* * * *

The discussion on this paper brought out the fact that control accounts with respect to Consumers' Accounts Receivable, are being adopted and operated more generally with the adoption of mechanical billing, and also that it is possible with the aid of machine billing to operate control accounts very satisfactorily. The representatives from offices where control accounts are successfully handled pointed out that the staff must recognize the importance of properly recording each entry, and the importance of accuracy

Mr. Darrell stated that several offices are operating Control Accounts on Consumers' Accounts Receivable without the aid of billing machines, and apparently they are meeting the situation successfully, although it was recognized that to do this without the aid of machines much labour must be applied.



The History and Present Status of the Low Voltage A.C. Network System

By D. K. Blake, Central Station Engineering Department, General Electric Company, Schenectady N.Y.

(Read before Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 8th, 1930)

THE low voltage a.c. network system is now regarded by most engineers as the best form of distribution for high load density districts. It has been adopted for this purpose by almost fifty operating companies. The installed transformer capacity is over 1,000,000 kv-a. with more than 4,000 protective devices called "network protectors". Most of these have been installed since 1926 although the first system was in operation as early
Any scheme of distribution that
as 1921.
interconnects the secondary mains of the distribution transformers may be classified as a network. An example is illustrated in Fig. 1. Such networks are as old as the industry and are very often described as "banking." Modern network systems, however, may be classified first according to the protective scheme and second, according to the secondary voltages. There are two types of protective schemes in use, the first is the well known network protector method (Fig. 2) which eliminates all high voltage devices and depends completely on the network protector connected between the secondary of the transformer and the network mains. Only two of the almost fifty network systems use high voltage protective equipment. The first and by far the largest is located at Philadelphia. This system is described in the *Electrical World* of September 25, 1926. It was decided upon at a time when the network protector development was new and difficulties were being encountered. The only other company to adopt this method was the Washington Water Power Co., at Spokane. The Philadelphia Electric Co., expect to continue their load growth with their original method but the Spokane Co., has recently purchased network protectors and does not intend to extend their old method. So, as far as protection goes, it may be said that the low voltage a.c. network protector

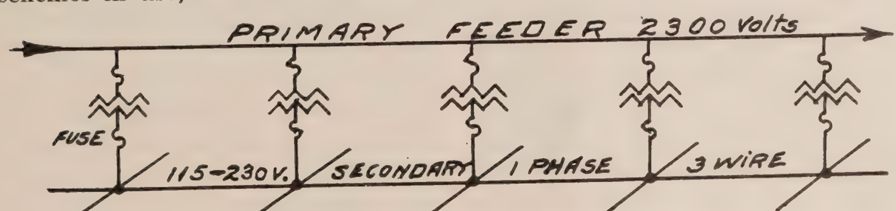


Fig. 1.—Earliest type of network formed by interconnecting transformer secondaries and supplied from one feeder only. Protected by fuses.

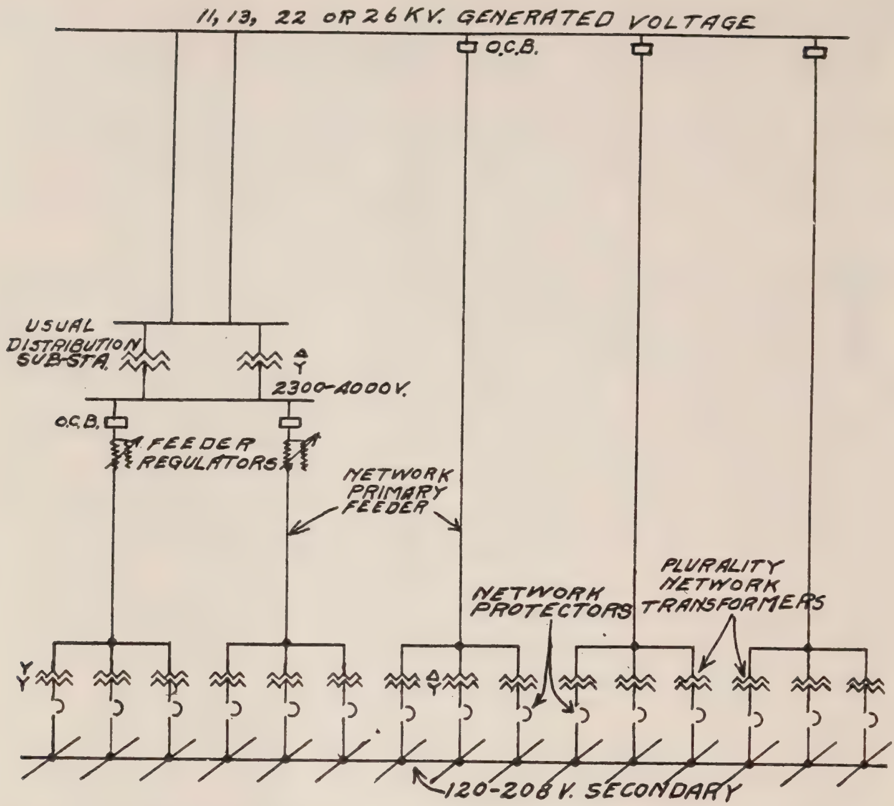


Fig. 2.—Modern form of network supplied from two or more high voltage feeders. More than two different primary voltages used in early stages with generated voltage only in final stage thus eliminating future need of additional substations

method is now universal in this country.

In the very early days of low voltage, a.c. networks, the systems could be classified according to the secondary system. The first system in Seattle was single phase, 3-wire. It was later made 3-phase, 4-wire by the addition of transformers connected in delta for power loads but all the lighting load had to be connected to the one phase making it necessary to have three separate networks in order to balance the lighting load over the three phases. Later these three networks were interconnected by the "translator", a magnetic device to permit an interchange of three phase power.

The Dallas Power & Light Company adopted the 7-wire system which has four wires at 115–199 to supply lighting load only and three wires at 230 volts to supply power load only. These seven wires were supplied from the same transformers and the voltages obtained by means of taps on the secondary winding.

The Philadelphia Electric and New York Edison Companies started their

networks, having a 2-phase, 5-wire secondary. All of the other systems at that time and since have adopted the 3-phase, 4-wire secondary supplied from Y connected transformers, giving either 115–199 volts or 120–208 volts for the light and power voltages. All of these systems are classified as combined light and power a.c. network systems. In view of the success with the 120–208 volt, 3-phase, 4-wire system the New York Edison discontinued the 2-phase, 5-wire and adopted the 3-phase, 4-wire. The Dallas Company and Philadelphia Company expect to continue their original methods. The Seattle Company expects to continue its interconnected translator network in the original network territory but the new underground territory surrounding this will be supplied from a network system utilizing the now well known 3-phase, 4-wire secondary.

It may now be said with the foregoing qualifications that the 3-phase, 4-wire secondary operating at 115–199 volts or 120–208 volts constitutes the universal secondary network voltages. So far as the remainder of this paper is concerned only this particular form of network with network protectors will be discussed. There is a decided preference for 120–208 volts wherever the operating companies are able to obtain this voltage. They now have had a number of years operating experience with both voltages with very successful results. A very small percentage of motors or devices give any trouble from subnormal voltage operation. This success is due largely to the practice of over motoring or starting torque being the main application requirement. Wherever such troubles are encountered or anticipated, the usual practice is to install auto-transformers. This, of course, increases the cost on the particular installations but the net cost in relation to the whole system is so insignificant that it is not a factor at all in deciding for or against the system.

Where are Secondary Networks Used ?

Any high load density area is suitable for a network system but heretofore, they have been used mostly in the commercial districts of the large American cities. However, the system is so simple and flexible that it easily proves to be the answer for an extreme range of load densities and a wide variety of load types. This is well illustrated by the extensive use of the system in metropolitan New York, (Manhattan, Bronx, Brooklyn, Queens) with the concentrated very high density area having large individual loads (tall buildings) in Manhattan on one hand and the numerous widely separated lower density areas with small individual loads (apartments, stores, theatres) in Queens on the other hand. The vertical network is by far the most satisfactory solution for very tall buildings, being similar to a short horizontal network except projecting vertically upwards. Some very large industrial plants, no doubt, will select this method in the near future.

Why Is The Network Used

Numerous studies made by as many different groups of engineers, some having widely different view points,

gives one conclusion ; namely, the low voltage a.c. network system is the most economical method known to provide for the rate of load growth. It is more economical because high voltage (13,200 volts) primary feeders may be used thereby avoiding the use of intermediate transformer sub-stations. All of this is accomplished with an increase in continuity of service which is inherent in the network and surpasses other a.c. methods. Sometimes the network is adopted where the rate of load growth is not sufficient to give a lower cost than other methods but the maximum of continuity is desired particularly from the viewpoint of equal reliability to small and large consumers alike.

When the network should be started is a question deserving very careful analysis involving all costs and accurate data pertaining to the load and its rate of growth. Observation over a period of years found a tendency to delay action based on a superficial examination of costs. Many times money has been spent along the lines of older methods only to find that such improvements were inadequate after a shorter time than anticipated.

The network system was then adopted but a substantial saving would have been realized if the network had been started on the previous occasion. The stumbling block in such cases is almost invariably the higher initial cost of the network over the increment cost of the existing or similar method. A study projecting all methods into the future will clearly reveal the difference in the increment costs of the various schemes usually with the network being lower where high load densities are involved. Knowing the lower increment cost it is a simple matter to determine if the load growth is increasing at a rate fast enough to justify the higher initial cost. In this connection, too much reliance should not be placed on the rate of load growth in the past for modern developments produce very large individual loads such as office buildings (300–5000 kw.), hotels (200–2000 kw.) theatres (300–

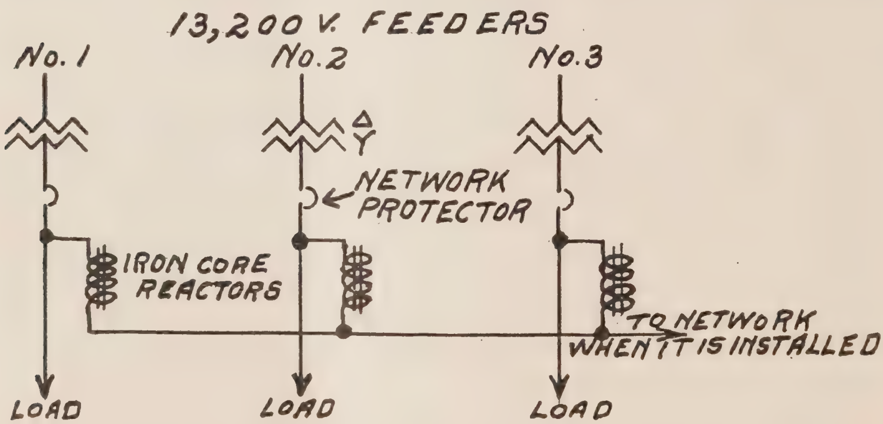


Fig. 3.—Common method of supply to large building loads. Very convenient to get network started by supplying all new large loads in this manner. Tie made to street network later after it is installed.

1000 kw.), department stores (300–5000 kw.). A few such installations would materially raise the rate of load growth in some places. In this feature of being adequate for any conceivable rate of load growth the network certainly surpasses other systems and, therefore, warrants full weight in deciding on the higher initial cost.

How a network should be started depends first on the load growth and second on the existing system. The higher the rate of load growth the less influence the existing system has. It is sufficient here to point out the very simple manner in which a large number of the systems have been started. New large individual loads are supplied with two or more transformers and protective equipment as illustrated in Fig 3. Sometimes two new high voltage primary feeders are installed to supply a single consumer alone. Additional large consumers are connected to these feeders as they come along. When these consumers occur close enough together the low voltage street cables are installed inter-connecting the building low voltage buses. The small consumers are then connected to the cables and they in turn are reinforced by the installation of transformers located in street or sidewalk vaults. Inasmuch as most of the load growth now comes in the form of large individual loads, it is expected that this simple process will prevail as the most suitable starting method. Some networks, however, are started with a concentrated group of small loads corresponding to a large individual load. Ultimately, such groups may become sufficiently close together to interconnect and form a larger network.

There are *some difficult problems* regarding rates, practice and policy requiring solutions or decisions when starting a network. These difficulties have been effective in postponing action on the network. It must be realized, however, that the mere postponing of the solution or decision by no means reduces the difficulties but to the contrary it increases them at least in degree and some times causes new ones. Experience teaches that one or more solutions are available and furthermore, are not nearly as difficult or serious as anticipated. Most of these matters are difficulties of transition and ultimately disappear as time goes on.

The early forms of networks depended on fuses for protection and were also limited to single feeder networks for that reason as well as others. Considerable trouble was experienced due to the low blowing value of fuses used as well as the inherently poor selective qualities of fuses. The blowing of one fuse generally meant the blowing of the others in cascade fashion with the consequent interruption of the entire network. Service could not be restored without replacing all fuses simultaneously, a very difficult procedure. For this reason a great many companies abandoned the practice, others increased the size of fuses, some added sectionalizing fuses in the secondary mains between transformers and a few adopted the Sprong-McCoy fuse arrangement subsequently developed. These schemes, even if successful, always meant an interruption to service with primary

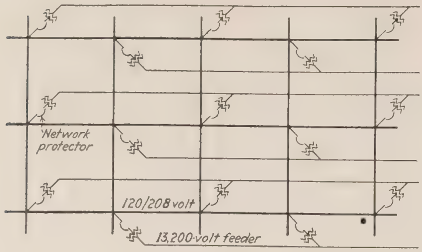


Fig. 4.—Street network for supplying numerous small distributed loads.

faults because they were supplied from one feeder only.

It became obvious to certain engineers that if the alternating current system was ever to be a serious competitor to the d.c. Edison system it would be necessary to have two or more primary feeders supplying the same network. The essential idea of a form of network illustrated in Fig. 2 is not at all new. It was patented in Germany as early as 1901 but was about twenty years ahead of its time for the load densities involved at the time were such that the Edison system with storage battery reserve gave a very satisfactory solution from the standpoint of cost as well as reliability. Furthermore, a.c. systems were not so well developed and were not nearly so reliable. This early German device consisted of a circuit breaker with a reverse power relay to trip at values as low as the exciting current of the transformer. However, it did not compare voltages and was unsuitable for systems having probabilities of slightly different feeder voltages caused by feeder regulators or tapped radial loads because of its tendency to "pump".

Under the direction of Mr. A. H. Kehoe of the United Electric Light & Power Co., of New York City, a similar development was undertaken some years prior to 1920. They included the feature of transformer exciting current trip but added the feature of comparing voltages to prevent reclosure when the transformer voltage was lower than the network voltage and substantially out of phase with it. The result was the development of a device that would perform two functions, first, a tripping function and second, a reclosing function. The reclosing function was essential because of the transformer exciting

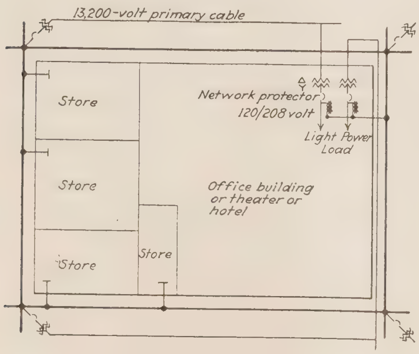


Fig. 5.—Illustrating the same continuity of supply to small and large consumers alike. Large loads tied in to street network.

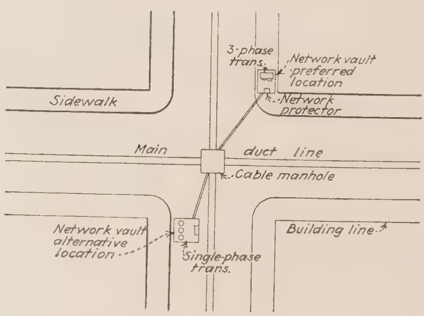


Fig. 6.—Illustrating physical arrangement of duct lines in street, also preferred and alternative location of transformer vault with network protector.

current trip. The latter was desirable in order to have all of the secondary network breakers (located in buildings or street vaults) open by the simple means of opening the feeder breaker at the station or source. Likewise, the closing of the feeder breaker would reclose all of the secondary network breakers provided the transformer voltage was high enough and substantially in phase. These devices were tried out on single-phase, 3-wire networks, having low voltage (3000 volts) primary feeders with encouraging results.

Some of the other operating companies had already established the practice of supplying alternating current distribution in the high load density district instead of extending the Edison system. Several factors were responsible for this attitude but the following will be mentioned :

(1) Increase of load in commercial area,
(2) Increase in extent of commercial area,
(3) New commercial or high load density areas in outlying sections,
(4) Greatly increased reliability of a.c. supply due to improvements in the art and interconnection of two or more generating stations.

The first factor has greatly increased the difficulty of obtaining suitable locations for additional Edison substations. The first two factors have greatly increased the expense of storage-battery capacity, while the fourth has reduced the value of such reserve capacity. The fourth factor is the reason why virtually all engineers believe the less expensive and more efficient a.c. systems should be used for the new commercial areas mentioned as the third factor.

Therefore, the development of a network protective device found a very fertile field for its application. Companies in New Orleans, Dallas and Memphis were the first ones outside of New York to make use of the device when they began in 1924 and 1925. (The Puget Sound Power & Light Co., of Seattle, however, had been operating a very similar network since 1921 but using manually operated oil-circuit breakers with ordinary reverse-power and overload protection for the automatic reclosing devices were not commercially available at that time). In the meantime, the United Co., of New York had enlarged their system. The New York Edison Co., also adopted the system for the Bronx district. These later systems were polyphase secondary having some high voltage (13,200 volts) feeders and some open delta connected single-phase regulators.

It is obvious that such a network system is simple in its general plan and variety of equipment employed. The low voltage protective device with relays, later called the network protector, is the only piece of operative and protective equipment involved. Therefore, much of the success of the system depended on the network protector. It was expected that some troubles would occur. Those that did occur are conveniently classified as mechanical and electrical. It will be sufficient to refer to just one very important electrical difficulty. Operating experience revealed that the relay characteristics were not suitable for a polyphase, high voltage

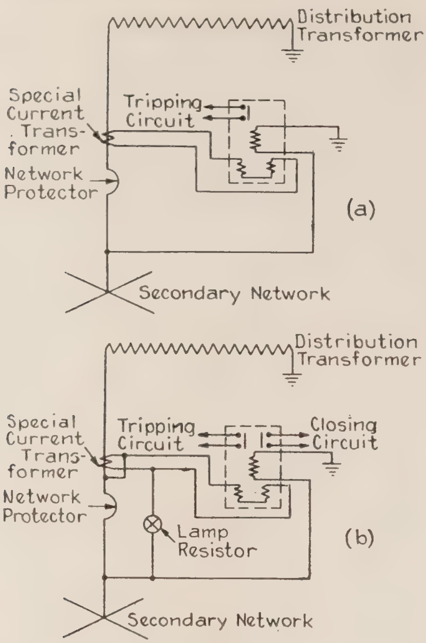


Fig. 7.—(a) *Illustrating simple watt-hour meter connection for reverse power feature, and :*

(b) *The simple added connection to provide for the reclosing function and thereby taking care of both reverse power tripping and voltage controlled automatic reclosing.*

supply with open delta, single-phase or polyphase regulators. Under certain circumstances these would cause the transformer voltage to lag, in phase position, the network voltage. The effect of this was to set up a circulating current and produce pumping of the protectors.

An analytical study of all possible combinations indicated that the relay characteristics must be modified to prevent reclosure when the transformer voltage lags the network voltage. This was accomplished by the simple expedient of adding a single-phase, induction relay so connected that it would close its contacts only when the transformer voltage was leading the network voltage from 0° to 180°. By connecting the contacts of this relay in series with the main relay it was possible to make the network protector pump proof as far as phase displacements were concerned. The device became, therefore, suitable for polyphase, high voltage regulated systems. While an understanding of the various voltage and current is somewhat complicated requiring explanation by elaborate vector diagrams, the actual mechanical construction of the relays are no more complicated than the ordinary watt-hour meter. The construction is almost identical with the electrical and magnetic constants different.

Where regenerative braking elevators were used by consumers they caused the protectors in the building or very near by to open because the energy of braking fed back exceeded the load in the building at certain times of the day. This was usually the case before the buildings were fully occupied. This has been provided for in a simple manner by adding as standard equipment an extra magnetic element energized by the three-phase voltage alone so as to give when connected, a torque on the disc in a direction opposed to the tripping torque. The effect of this is to increase the current required to trip. A spring could be used for this purpose but is limited in range whereas the voltage restraint gives a greater range because its restraining torque goes down with the voltage and prevents an increase in the tripping current required with low voltage

accompanying short circuit conditions. The restraining element is also useful where two different primary voltages feed the same network. A slight phase displacement causes some of the protectors to open and remain open until the voltages come together again. This is objectionable not only from the standpoint of reliability but also from an operating point of view because the sudden application and withdrawal of a substantial load (like elevators) near an open protector, cause enough voltage drop to close the protector which opens again as the load decreases. The frequent operation of the protectors is sufficiently objectionable to some engineers who have accordingly adopted the increased setting for all new equipments. This practice of course, prevents the opening of the protectors by means of the transformer exciting current and necessitates at present, a visit to each location for manual tripping of protectors to completely de-energize a feeder. In the future some form of artificial load may be added at the station end or else pilot wire schemes introduced. However, most companies are satisfied with an occasional use of heavier settings and willing to visit these few locations, if necessary.

The earliest network protectors were tripped by means of an undervoltage device. Considerations, later borne out by experience, revealed this an undesirable feature in order to be applicable to all systems because of unnecessary and undesirable operation during system disturbances. Accordingly the shunt trip coil was developed to give a position trip as well as be independent of voltage

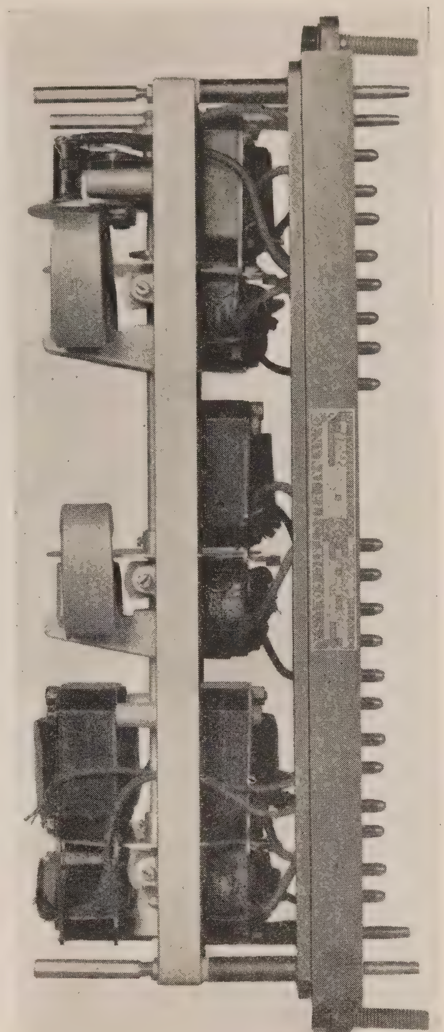


Fig. 8.—Modern network relay similar to watthour meter construction having removal facilities in the form of plug-type terminals which fit into spring jack receptacles in panel. Magnetic element on front recently added to give voltage restraint to permit raising reverse power settings where regenerative braking of elevator equipments give trouble.

disturbances. This required a wide range of voltage such as 15 volts to 208 volts. The problem was to have enough force at the lower voltage and not require excessive current at the normal voltage and endanger the relay contacts. The 15 volt limit gives ample protection for the transformer reactance and assures greater values under primary short circuit and the arc voltage under secondary shorts. The trip coil is connected across two of the phase wires, assuring at least 115 volts for single phase primary shorts and line to ground secondary shorts.

It was soon appreciated, therefore, that the network protector was after all no more than an electrically operated circuit breaker with a reverse power relay connected in an ingenious manner to perform some elaborate functions. Even if the devices gave some mechanical troubles and required maintenance what did that matter as long as they meant no interruption to the consumers' service. From the executive's viewpoint the network protector simply meant more trouble to his Distribution Department, which was acceptable so long as the system gave continuous supply to his consumers and eliminated complaints coming to his desk. He would rather have troubles in his Distribution Department which he never hears about than on his consumer's service which he immediately hears about with a great deal of emphasis. Modern network protectors are a considerable improvement over the earlier devices and may be said to be thoroughly reliable even though they will always require some attention.

It is doubtful if any electrical device has had to pass through as rigid and exacting scrutiny as has the network protector. Time and again it has been subjected to tests by engineers of companies intending to purchase them. Changes of the smallest details have been made to meet the criticisms of purchasers. Testing and removal facilities have been added to facilitate maintenance and inspection.

One of the most interesting features incorporated in the protector that is new in Central Station Switchgear practice is the silver to silver main current carrying contacts. A consideration of the factors affecting temperature conditions (such as, high vault ambients, close proximity to the transformer (a higher temperature device) possibilities of overloading, restrictions of air circulation by using submersible housings and the burning clear of secondary cables during short circuit) revealed that a network protector must not have a critical temperature limit of 70° C. like the ordinary laminated brush type copper to copper contact. If the usual copper laminated brush is repeatedly operated much above 70° C. in time, two things may develop. First, the pressure will decrease and second, oxidation of the contacts will take place at a more rapid rate. Both effects are accumulative with the probable result that the breaker will overheat to a point of uselessness or destruction. If, however, contact pressure is maintained by a separate non-current carrying steel spring, the pressure will not change perceptibly even at very high operating temperatures. Silver to silver contacts eliminate oxidation troubles because silver does not oxidize readily in air

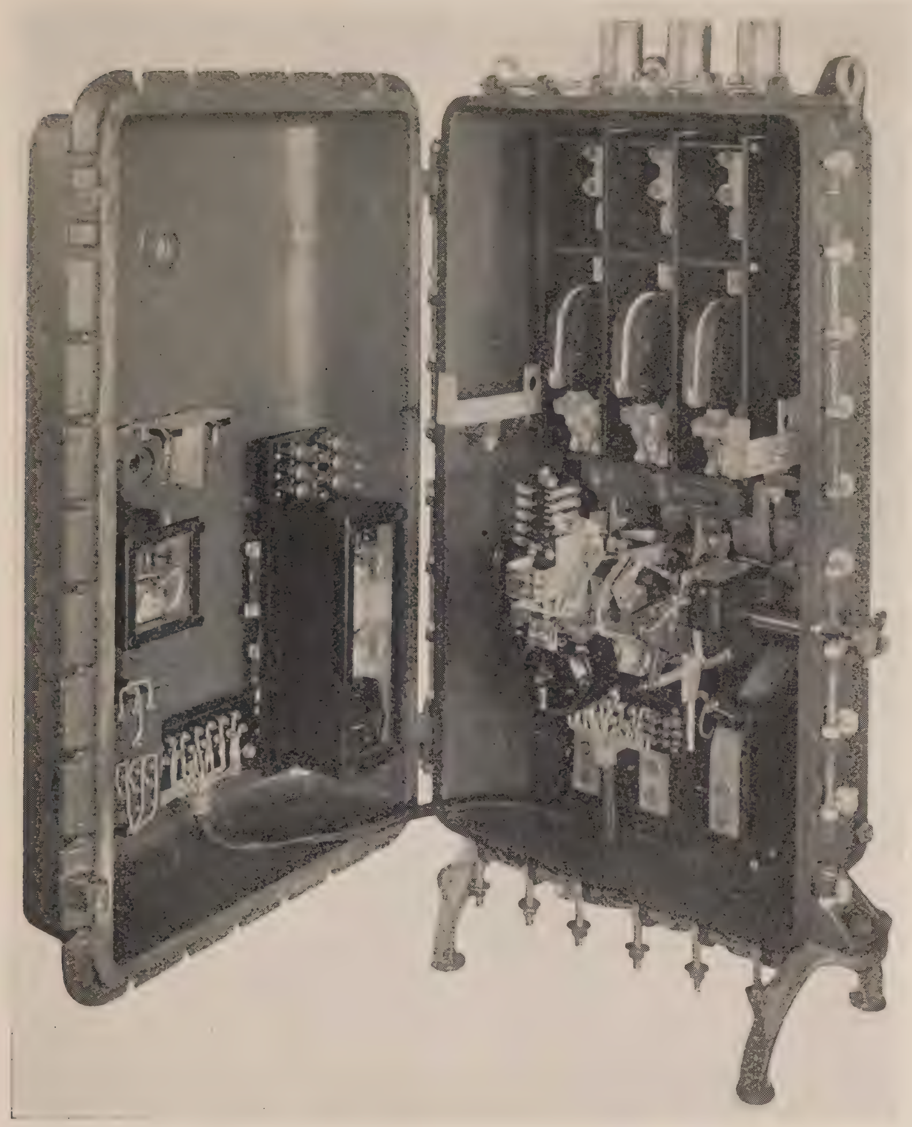


Fig. 9. (a)—Modern motor operated submersible type network protector. Relay equipment mounted in cover.

and if it did silver oxide is still a good electrical conductor whereas copper oxide is not. Such a contact construction does not have a critical temperature limit and is perfectly safe at temperatures well above a value one would care to operate at. Due to the steel spring and mass of metal it makes no practical difference in the temperature rise whether the contact

is a flat surface having a large area, a line or a point. The contact resistance depends on pressure times area and this product remains constant regardless of the area as long as the total spring pressure is the same. The result of incorporating this feature is to virtually eliminate contact heating as a source of maintenance.

The small motor centrifugal mechanism was applied to the protectors because it was a more efficient way of operating the higher ampere capacities such as 1200 ampere submersible type and higher. The solenoid mechanism is a more simple device than the motor operated and has a lower cost within its range of application. The heavier mass of moving parts in the high ampere ratings make a centrifugal mechanism preferable because it has its maximum closing torque at the start and minimum at the finish whereas the solenoid is just opposite. The strains in the solenoid mechanism become more difficult with an increase in current rating.

The network protector, therefore, constituted the major problem of lower voltage a.c. network development. The remaining work to be done along these lines consists of standardization and simplification. There were *many other very important problems* to be studied, however, but these were rather simple in their nature and usually admitted of two or more solutions. The result, of course, in such cases is that some engineers decided one way and some the other and, thereby, becoming matters of opinion. These problems have already been discussed in detail in various technical articles and for

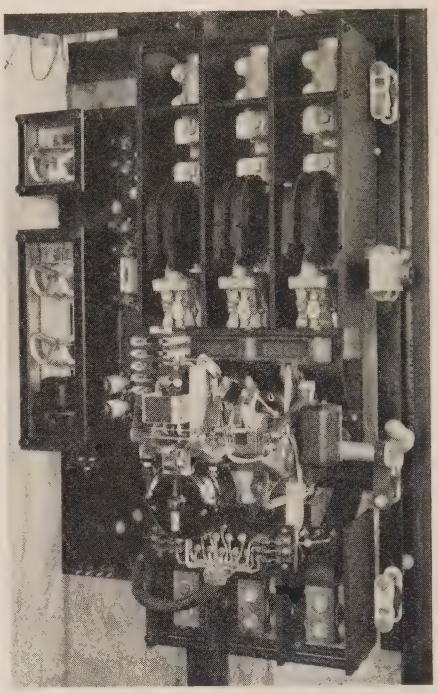


Fig. 9.—(b) *Non-submersible, motor operated type.*

that reason it will be sufficient to just review a few of the most important ones with some statements as to the relative practice.

The clearing of faults in secondary cables has involved a great deal of discussion and no small amount of testing. The idea is to depend on the fault burning itself clear without resorting to fuses. Some companies do make use of fuses but they are so few in number that the burning clear practice may be said to be universal. It is the general practice not to use secondary cables larger than 500,000 cir. mils because the current required to clear a fault becomes excessive. Tests show that there is a wide difference in the amount of

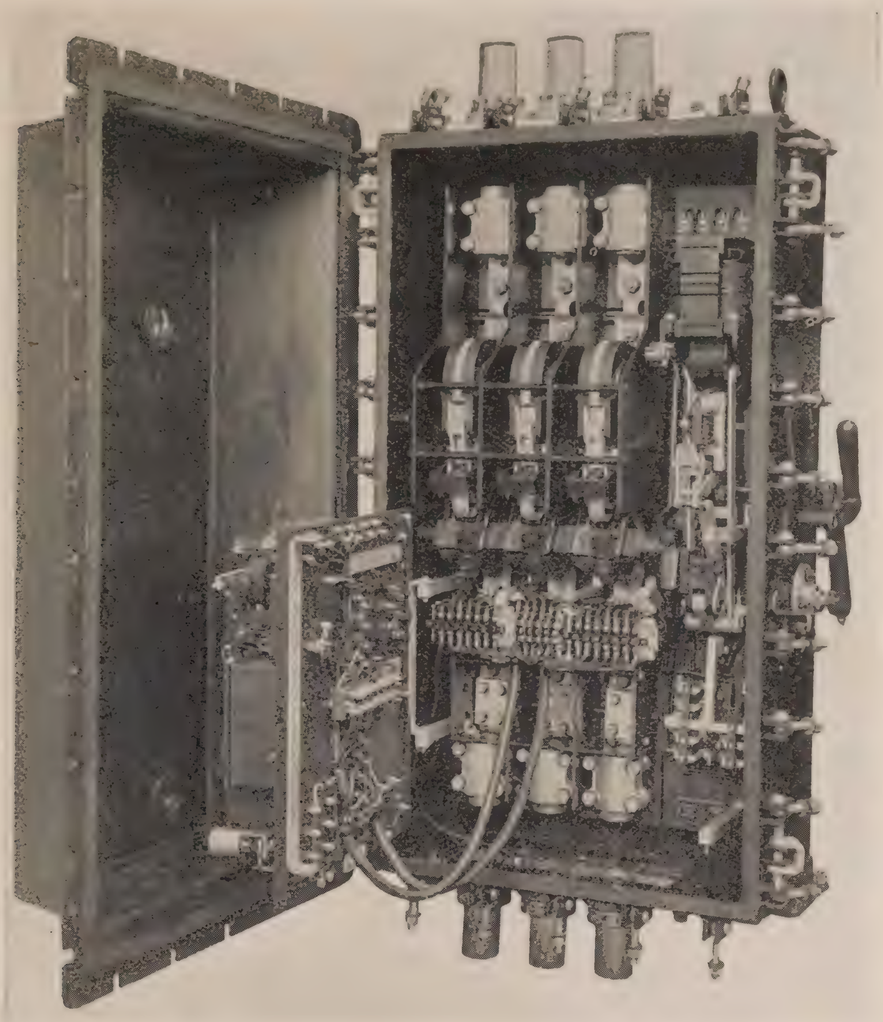


Fig. 10. (a)—Modern solenoid operated submersible type network protector. Relay equipment mounted on hinged panel.

smoke, gas and explosions between clearing 500,000 cir. mils cables and clearing 250,000 cir. mils cables. For this reason a few of the companies believe it a better policy to use two sets of 250,000 cir. mils. cables in parallel instead of one set of 500,000 cir. mils. Most companies, however, use the larger cable objecting to the greater cost and multiplicity of splices and services required when using two sets of mains in parallel. Sometimes it is convenient and economical in lightly loaded districts to start with the small cable and add a second one in parallel when the load density

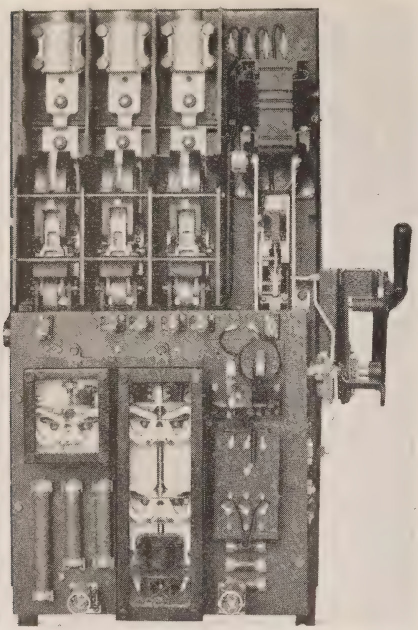


Fig. 10.—(b) *Non-submersible, solenoid-operated type.*

increases. Careful attention must be given this point for if the larger cable is used in the beginning it may require much more installed transformer capacity in order to obtain enough current to clear the larger cable. The current chosen is that required to melt the copper with a solid short and is less than 3500 amperes for 250,000 and 7000 amperes for 500,000 cir. mils cable. Where there are long sections between junction points it is very probable that a copper to copper fault will cause the destruction of the entire length of cable and clear in one of the manholes or at the junction splice. For this reason it is not necessary to apply transformer capacity based on the current at a fault in the middle but just beyond the junction splices. While enough current may not be available to melt the cable, the charring away of the insulation will ultimately produce a fault near the junction splice that will give the required current to melt the cable. The division of current among the cables connected to the junction splice will give about $\frac{1}{4}$ or $\frac{1}{9}$ the heating which is very probably low enough to be safe for the time required to clear the faulty cable. Further experience, however, may be required to put this point beyond question.

Transformer reactance has some bearing on the division of load between transformers and for this reason has been a subject of discussion as to the correct amount to provide. The problem is very simple being merely a matter of determining whether it is better to spend money for reactance and carry more load for the same transformer capacity or else provide additional capacity. Inasmuch as the loads are not uniformly distributed and also provision must be made for a transformer being out of service, it is obvious that the transformer nearest the load will carry the highest percentage and therefore, reach its rating first, thereby, limiting the total load that can be carried. Increasing the reactance of all the transformers will cause an improved division and permit utilizing more of the installed capacity. A little consideration will show that it is a question of the ratio of the transformer reactance to the cable reactance between transformers. The magnitudes of the improvement are indicated in Table I where is assumed a simple case of two remote transformers interconnected by a cable

TABLE I.

Relative Reactance		Transformer Load in Per Cent.	
Cable	Transformer	No. 1	No. 2
1	0.25	16.5	83.5
1	0.50	25.0	75.0
1	0.75	30.0	70.0
1	1.00	33.0	67.0
1	1.25	35.8	64.2
1	2.00	40.0	60.0
1	3.00	42.8	57.2

supplying a concentrated load, located at one of the transformers. Where more transformers are involved as in an interconnected network, the less need there will be for additional reactance. It is agreed, however, that higher than 10 per cent. transformer reactance is unnecessary and undesirable. Where 10 per cent. is used throughout it is cheaper to purchase transformers having 10 per cent. inherent reactance. However, only a very few companies do this but make use of external reactors to bring the total up to 10 per cent. This is more expensive for a particular installation requiring space for installation but is flexible in that it permits their entire removal if desirable later or else permits selecting locations where they might be needed and omitted where they are not needed. Some companies just use the normal reactance believing it better to accept a slight derating of transformers which may be more theoretical than practical because the difference is usually well within that usually provided for load growth.

It is general practice to use reactors in a star-bus arrangement where large building installations require two or more transformers. In cases where the network is supplied from two or more voltages it is usually necessary to add additional reactance, above the normal value to the transformers supplied from the higher voltage primary circuit to balance the reactance of the transformers supplying the lower voltage primary circuit. In such cases it is best to have only the normal reactance in the transformers of the lower voltage primary circuit.

Voltage regulation has presented no serious problems that have not been satisfactorily solved. The high load densities, high voltage primary circuits and the uniform size of transformers makes it very satisfactory, in most cases to provide bus regulation only. The next in order of preference is group feeder regulation and finally individual feeder regulators. The latter presents the most severe case of stable operation of regulators but may be easily solved by electrical interconnection of the control circuits. However, experience now indicates such interconnections are conveniently avoided by under-compensating slightly so

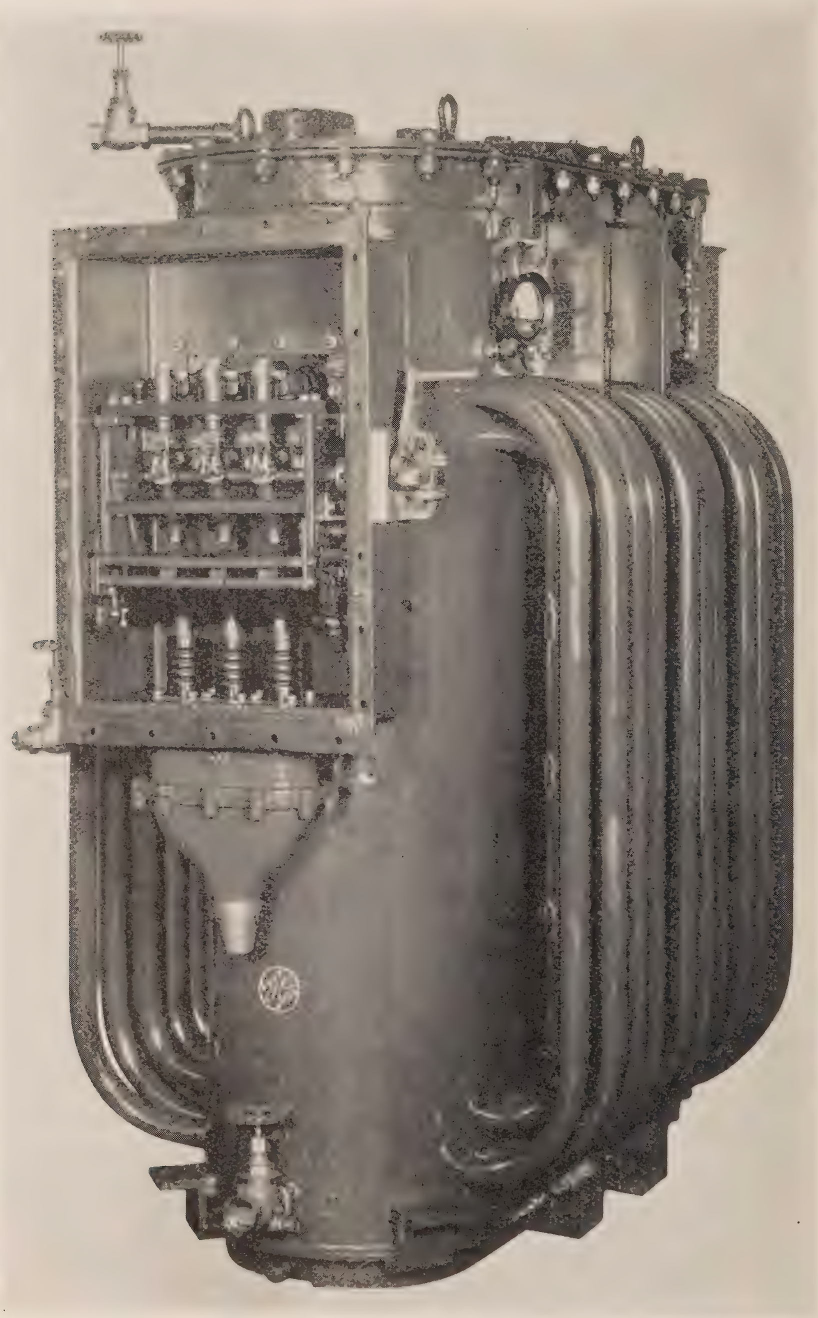


Fig. 11.—Modern, 300 kv-a., 11 or 13 kv. subway type network transformer. High voltage pothead and three position switch compartment on one end and low voltage terminal box on opposite end. For street or sidewalk vaults likely to be flooded.

that the contact-making voltmeter has complete control at all load conditions.

The network, being a combined light and power system, requires the limitation of the *motor starting currents* to a value that will not produce a sudden voltage drop that will cause objectionable lamp flicker. The limits chosen for design purposes lie between two and three per cent. These values permit a large percentage of motors to be started across the line without compensators but also require a few very large individual motors to be provided with increment starters to limit the amperes per step. Some companies prepare tables to show the starting limits at various distances from the transformers. Another method is to allow a certain starting current at every point on the network and increased from this value in proportion to the load demand. This method has the advantage of simplicity but of course, provides for the remote consumer without allowing the full benefits to a small consumer connected near a transformer bank.

The *relation between transformer rating and peak load* at the present time is not representative of what will be the case in the future. A transformer rating 50 per cent. greater than the peak load is about as good as can be expected for an ultimate value in general. This is due to the practice of allowing for one feeder out under peak load without overloading the remaining feeders and transformers, it being very difficult in practice to so interlace the various primary feeders so as to have the load picked up by more than two adjacent feeders. The extreme emergency of two feeders out is thus provided for (where four or more feeders are provided) by falling back on the ability of the equipment to withstand a short time overload. The necessity of providing for load growth and burning clear of cables also accounts for a larger transformer rating than necessary for present peak load. It is now very common for systems to have 100 per cent. excess capacity and a few cases reach 200 per cent.

The network system has affected the design of the *distribution transformers* with respect to reactance, size, voltage, mechanical features and accessories. The transformers for network systems are of a larger and more uniform kv-a. rating than are used in earlier types of distribution systems. It is seldom that a system requires more than two sizes, and some systems have only one size for the street vaults and larger ratings in building vaults when very large building loads are involved. In the greater number of systems, transformer installations of 300 kv-a. banks are found more economical than other ratings. The use of the generated or transmission voltage for the network feeders required the development of subway transformers of higher voltages such as 11,000, 13,200 and 26,400 volts. Wherever possible three-phase units are generally used because of the smaller floor space required and much simpler vault installation by eliminating much cable splicing and racking. Two position grounding switches and three position grounding and disconnecting switches on the high voltage circuits are very generally used and mounted

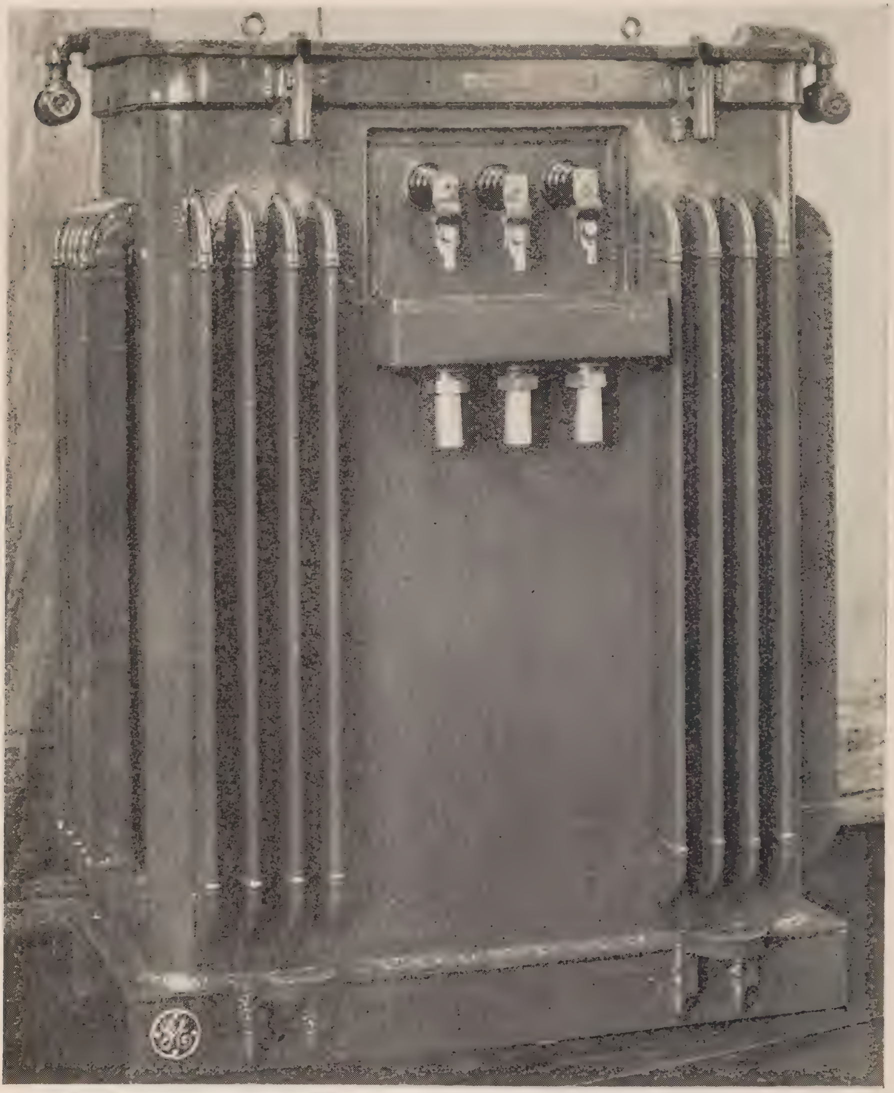


Fig. 12.—Modern 300 kv-a., 11 or 13 kv. vault type network transformer. Metal cover removed to illustrate simple method of terminating and sealing high voltage cable by filling with compound. For building vaults or sidewalk vaults not likely to be flooded.

on the transformer case. These devices are required by operating companies for grounding and "phasing out" facilities. It is desirable to limit such devices to as few a number as possible.

Transformer vaults vary greatly in dimensions. A vault nine feet high is very common with widths about eight to ten feet and lengths ten to fourteen feet, covering a great number

of cases. Natural ventilation is generally used, consisting of cold air inlet at the bottom and warm air outlet at the top. The dimension of such opening varies too widely for general statements. A large number, however, come within the limits of 1 to 1.5 sq. ft. of total opening per kilowatt loss, neglecting the conduction through wall surfaces.

Discussion

Mr. D. K. Blake :

Gentlemen, I have chosen for the subject of the paper the history of the present status of the low voltage a.c. network system. Inasmuch as this subject is covered in a paper, and as I feel quite sure many of you are interested in other aspects of the distribution of electrical energy, with your permission I am going to make a few remarks upon the subject of distribution of electrical energy in general. I would like to re-state some things that all of us know. The reason I want to re-state them is to emphasize some things that we forget.

I think it is well from time to time to even re-state again the purpose of an electrical service system, and of the electrical engineers of Utility companies. Surprising as it may seem, we even forget our purpose. Now what is the purpose of an electrical service system, regardless of who runs it ? There is only one purpose, and that purpose is to render electric service. Electric service is not an indefinite term or idea. It can be measured, and is measured in two terms : the first and foremost is continuity of supply—that is, uninterrupted service supply, and the second is voltage regulation. These two together measure the degree of electric service that you are rendering. Both of them must go together. There is considerable interest at the present moment among a large number of engineers regarding the question of voltage regulation. The question of the voltage applied to the lamp is one that, no doubt, a number of you are interested in at this very moment, or will be very soon. We have forgotten that the cost of the lamp has decreased rapidly over recent years. It has changed the picture of the lamp situation as far as the life of the lamp is concerned. It pays everybody, the consumer, the utility and the manufacturer, to operate lamps at least at their labeled voltage and not below their labeled voltage. It is even more economical to the consumer, considering the quantity and the quality of the light to operate his lamps above normal voltage. It is also economical to the Utility to operate his lamps above normal voltage and of course it is obvious it is an advantage to the manufacturer.

Take the question of economics as applied to administration or to transmission. Economics does two things for us. In the first place, it tells us how far we may go in spending money to give the highest order of electric service that the art permits. Secondly it gives us two ways of accomplishing the same result. We must take the one having the lowest cost, and that is always expressed in annual charges in order to be fully accurate. I have found it convenient, in studying

economics of systems, to consider certain factors which we have to deal with from time to time, namely, diversity factors and load factors. If you take a text book to find out what is the diversity factor, you will get some kind of definition about the simultaneous demand of a group of loads either divided by or into the sum of the individual demands of the groups. Diversity factor taking it one way or the other tells you how much equipment in kv-a. you must have to supply a given group of loads. In other words, the diversity factor determines the investment in your system.

The text book definition tells you, if you take the average load over a period of time and divide by the peak load during that period, then you have the load factor. What does that mean ? Load factor tells you how much you use the equipment you have, and, in terms, the losses in your system. Diversity factor influences the investment, and load factor influences the losses in your system. Then, trying to give some further picture of the electric service system, and showing how the diversity factor has an effect upon the amount of kv-a. I have divided the system up into four major divisions. The first is generation, next is transmission, third is sub-stations or transformation, and the fourth is distribution. That is virtually a four-link chain, and we all know that a chain is no stronger than its weakest link. So, after we have done all that we can to improve the continuity in generation, in transmission and in transformation, yet the service rendered by that system is no better than the service rendered by the distribution system, because you are interested in continuity to the consumer and not just continuity at the sub-station. The same with the question of economics. Go ahead and increase your steam pressures, and improve the efficiency of your boilers and generators and your large power transformers, and save every lost kilowatt-hour right on up to the sub-station, but throw it away when you get out into the distribution system, with light overhead circuits, the multitude of small capacity, distribution transformers, and the long, small, secondary circuits overloaded, and it can be said with a certain degree of accuracy that the efficiency of your system is still no better than the efficiency of your distribution system after you have obtained perfection in the other three links, viz., generation, transmission and transformation. The investment in the last link is a very high percentage of the total, depending upon the city and the load. Taking a one hundred thousand kv-a. generation station, and a diversity factor of 1.1, it immediately tells us that it supplies a transmission system that supplies 110,000 radial kv-a. Now usually we base our system on the basis of radial design, so what goes through our transmission, also goes through our transformer sub-stations. Speaking now of stepping down, assuming a metropolitan system of 13,000 volt underground transmission, and 4,000 overhead distribution circuits, we also have about 110,000 kv-a. in sub-station transformer capacity. Then if we have a diversity factor of 1.8 between the distribution feeders and the 110,000

kv-a. in sub-station transformers, we have almost 200,000 kv-a. in distribution transformers, or twice as much capacity as the generating station. Then you take the load factor, and start with the consumer and you will say he has a load factor of 20 per cent. on the distribution transformer, and work on back, and you can very conveniently, knowing the diversity factor, bring it back to the generating station. You will find maybe 40 per cent. and some times a higher load factor on the generating station. So then the picture is this—that you have, at the distribution end, twice as much capacity as at the generating end, and to my mind that is a sufficient picture to emphasize to anyone that the distribution end, even though it is a little simple transformer hung on a pole, claims the attention and the analysis of the best kind of intellect that we have in the engineering profession. At this point I want to emphasize what I believe is a simple method of planning and of studying distributing systems from the standpoint of economics. Most people, I find, have a tendency to go from the generating station to the consumer. I have found it much more convenient, and, I believe, accurate, to start with the consumer and work back to the generating station. When you undertake to analyze the distribution area, you have in that area given loads and consumers spaced so far apart. Based upon your cost and their load, which in turn will give you their density over a given area, your first step is to determine the relation between the transformer size, the secondary copper size, and of course that will give you the spacing between the distribution transformers. They are independent of anything else that you might do in your system. It is true that the voltage on some of these transformers will have some effect, but not very much. So, if you determine that ratio, then you are independent of anything you may do from that point on. Then, instead of using the consumers as units, you could use the distribution transformer itself as a unit and you would do exactly the same as you did before, except that this time you would group the number of transformers together, which would determine for you your load centre, which would determine for you the length of distribution feeder from the sub-station to load centre, and that would determine for you the spacing between your sub-stations.

There are three distinctions to be made in studying electrical distribution to metropolitan districts. There are three areas. The first is the residential area, which is a large area having small loads, spaced closely together. The next is the industrial area, having large loads, relatively widely separated. The third area is the commercial area, having both small loads and large loads close together, and the area itself is small, giving you very high densities. You have three distinct areas which are treated separately and give different results.

Now take the question of high voltage. It is easily seen that, since the distance between the loads in the industrial areas is quite large, and the loads themselves are large, there is the question of carrying more load and covering more distance and the

higher voltage ought to work out better in an industrial area than it would in a residential area, where the loads are close together and the loads themselves are small. I think you will find that generally true, that to distribute high voltages is more economical in large industrial areas than in residential areas, leaving out other considerations of clearances and space which limit the application of higher voltages to residential districts, even if they were more economical.

Then you have the underground district. Now that district, as all of us know, requires and deserves the highest order of electric service that the art knows anything about, and that brings me to my subject of the low voltage a.c. network system.

Mr. E. V. Buchanan, London :

Mr. Chairman and Gentlemen,—I was very glad that Mr. Blake digressed from his paper at the beginning to give some general remarks on distribution. Some of you will remember that, at the Winter Convention, I mentioned this matter in connection with the work that was being done by the Hydro Commission in research. I pointed out that, whereas engineering practice had developed efficiency to a very high state in generation and in transmission, nothing had been done in connection with distribution and utilization and that, in distribution, our losses were extremely high, and I urged that Mr. Dobson be given more appropriation, if necessary, to spend some time on such problems as Mr. Blake mentioned. Just in that connection, although it was not in direct relation to his paper, Mr. Blake spoke of lamps and lamp voltages. I think a word from Mr. Dobson on Hydro lamps and Hydro lamp specifications might be interesting to the delegates here, because our conditions are somewhat different from the United States, where they have cheap lamps and high prices for current. We saw yesterday, in Mr. Lawler's paper, something of the problems of distribution, and I really think that these two papers are of real benefit to the delegates from the municipalities. Mr. Blake stated that this system of a.c. networks was chiefly applicable to high load density districts. I am just wondering if Mr. Blake realizes how dense our residential loads are. There is no place in the world, I think, where residential load densities are so great as they are in Ontario. Domestic connected loads, I suppose, will run from ten to thirty kilowatts. In fact, I know of some houses that have sixty killowatts connected load. I have always had the big idea that we should use higher voltages in these districts, that there is very little sense in using twenty-three hundred volts, instead of 13,000, and in the past the only limitations seems to have been the development of equipment to handle the higher voltages. In studying this matter in London, Ontario, we wanted to get a wide picture of the economics of the system, and we took the cost of our total distribution system, which I think ran around two and a half million dollars, money that was invested in the distribution system at a time when prices were much in excess of what they are to-day. We worked out a hypothetical case for putting a networking system over the entire

city and covering the city to an extent not even recommended in Mr. Blake's enthusiasm. The result was that, at present day prices, we could cover the city of London with a network system for less money than the actual cost of sub-station and radial distribution. Mr. Blake emphasized the point that the starting of the network system was not dependent on the present load, but on the load growth. I think we all realize how rapidly the load is growing in Ontario, due to the low prices of the electrical energy, and for that reason I think this matter ought to be given serious consideration by any municipality which, at the present time, is considered in the class of our city.

Mr. C. A. Price, Canadian Westinghouse Co., Limited :

Mr. Chairman and Gentlemen,—It seems to me that Mr. Blake has certainly brought to us a subject which we are not only interested in as users but as manufacturers. I may be mistaken, but I don't think there is a network system using network protectors in use in Ontario, is there ?

Mr. Buchanan : No, not yet.

Mr. Price : I know there are two or three projected, and I think Mr. Buchanan's is one of them.

Mr. Blake touched on one subject in his opening remarks, which the Canadian Engineering Standards Association have given considerable work to, and that is voltage standardization. Probably every one of us here has seen those standards for distribution transformers, and we work pretty close to that standard. The Association have now in process the standardization of larger transformers, which, no doubt, in the course of time, you will receive copies of and they will be approved. He touched also on the reliability; and I happened to see some figures, not very long ago, on the reliability of these network protectors, and according to the statement there of some 200,000 operations, there have been less than one-half of one per cent. failure with these network protectors. He also touched on the percentage of cost of distribution systems. Some figures I happened to read the other day were the same that he mentioned, namely, about 33 per cent. It may be larger in some cases and smaller in others. But I wonder if Mr. Blake realizes that in Ontario our frequency is 25 cycles. I noticed, in his paper, and some other reading matter I happened to have, that they recommend transformers having about a ten per cent. reactance. This reactance can be obtained in three ways : first, by designing transformers with inherent reactance—that is arranging the windings so as to obtain, this high reactance; the second is to build transformers with iron shunts and the third method is to use transformers with normal reactance and use external reactors. On 25 cycles, the cost of a transformer with 10 per cent. inherent reactance is high. Using transformers with, say, 4 or 5 per cent. normal reactance and iron shunts, it would go somewhat lower. With the normal transformer you would have to use external reactors, and possibly on some systems that might be the best solution because it is more flexible. There is one point that Mr. Blake also touches on in his paper, and that is the

possibility, when you are using this network protection, that you can always work your apparatus at the highest efficiency. That is, you can cut off and keep the other transformers on for the greatest part of the operation at highest efficiency. Another point he touched on is the operation of these net work protectors with regulators. In some of our cities, that is a question that will have to be studied.

Mr. J. W. Peart, St. Thomas :

Mr. Chairman, I notice in Mr. Blake's paper that he justifies the cost of the network by the elimination of the sub-station. That would mean that trunk feeders originating at the H.E.P.C. stations would terminate in these transformer vaults, as I understand it. I would be interested in knowing just what stand the engineering department of the H.E.P.C. would take in this matter. I believe that they are vitally concerned in their relay protection, and insist that it be carried out at both ends of the trunk feeder. I am not quite clear as to the protection afforded the 13,000 kv. cable at the transformer vault.

Mr. Blake : I do realize that you have somewhat different conditions here, namely, very much higher density in the residential districts and the use of twenty-five cycles. I should have kept that in mind when I made the remarks about the lamp, because the cost of energy has considerable to do with the question as to what voltages are being used, and also the lower the cost of the energy the lower the voltage that would be applied to that lamp. On the question of voltage regulation, if the regulators are necessary, I think you will find, in the literature available, sufficient solutions to any troubles that you may encounter. I think I can assure the gentleman who raised the question about the protection that, as far as that feeder from the generating station is concerned, it doesn't make any difference whether it terminates at the high voltage bus of the receiving sub-station, or in the pothead of the network transformer, because the power relay on the network protector is identically mechanically the same as the reverse power relay he would use on those feeders in the first case. It is sufficient to say that the low voltage network protector gives ample protection to the feeder. In the case of a feeder failure, the network protector will clear all the transformers from the network. You do not need to make any change in your relay conditions at the generating station.

Association of Municipal Electrical Utilities

Minutes of Convention

The Twenty-seventh Convention of this Association was opened at Bigwin Inn, Lake of Bays, Muskoka, at 1.30 p.m. on Monday, July 7th, being called to order by the President.

The Secretary read the following names for admission to the membership of the Association :

For Commercial Membership :

The Jas. Moncur Electric Co., Ltd., Hamilton, Ontario.

Associates :

Messrs. A. V. Trimble, I. K. Sitzer, H. J. Muehlman, J. Dibblee, J. D. Pace, G. Pace, D. A. McKenzie, C. B. Sharp, S. M. Richardson, W. Lawson, A. S. Robertson, H. M. King, and Stanley Thompson.

It was moved by Mr. O. H. Scott and seconded by Mr. R. H. Starr, that the names read by the Secretary for commercial membership and associates be declared elected.—Carried.

Mr. E. R. Lawler, Assistant Engineer, Municipal Engineering Department, Hydro-Electric Power Commission of Ontario, read a paper entitled, "Load Unbalance on Single-Phase Distribution Secondaries." The discussion following this paper was by Messrs. J. E. B. Phelps; P. B. Yates; J. J. Jeffrey; R. H. Starr; M. J. McHenry; H. F. Shearer; W. P. Dobson; E. V. Buchanan; T. C. James.

Following this paper and discussion it was moved by Mr. P. B. Yates and seconded by Mr. J. E. B. Phelps, that the question of load unbalance on single-phase distribution secondaries be referred to the committee appointed at the previous Convention to work with the Hydro Laboratories on research.—Carried.

The proceedings then adjourned.

The second session of the Convention was opened at 10.00 o'clock on the morning of Tuesday, July 8th.

Mr. D. K. Blake, Central Station Engineering Dept., General Electric Company, Schenectady, N.Y., read a paper entitled, "The History and Present Status of the Low Voltage A. C. Network System."

The discussion following this paper was by : Messrs. E. V. Buchanan, C. A. Price, J. W. Peart.

Mr. R. T. Jeffrey, Chief Municipal Engineer, Hydro-Electric Power Commission of Ontario, gave an address entitled, "Hydro Progress," which was illustrated by maps and charts. Proceedings then adjourned.

At 12.30 p.m., the Association met, together with the O.M.E.A., for its Convention luncheon, when addresses were given by Mayor Wemp, of Toronto, and Mr. George D. Leacock, President, Moloney Electric Company of Canada.

In the afternoon, at 6.30 o'clock, the Association met, together with the O.M.E.A., for a Convention dinner, when Mr. C. A. Maguire, President, O.M.E.A., was toast master.

Short addresses were given by Mr. J. C. Miller, Commissioner, Orillia Water, Light & Power Commission, who was guest speaker, and by the

Mayors of cities and towns who were present at the Convention.

Mr. Maguire expressed the thanks of the Associations on account of the Northern Electric Company, Limited, having installed an address system in the main dining room for the use of the speakers.

The third session of the Convention opened at 10.00 o'clock on the morning of Wednesday, July 9th.

Mr. T. A. Chisholm, Chemist, Hydro-Electric Power Commission, read a paper entitled, "Paints and Painting, Practical Suggestions from the Experience of The Hydro-Electric Power Commission of Ontario."

The discussion following this paper was by Messrs. W. P. Dobson, E. V. Buchanan, A. B. Scott, R. H. Starr, E. R. Lawler, and R. H. Martindale.

Mr. George W. Hague, of Campbell-Ewald Limited, Toronto, read a paper entitled, "Merchandizing of Domestic Load Builders by Public Utilities."

The discussion following Mr. Hague's paper was by Messrs. E. V. Buchanan, A. W. J. Stewart, E. M. Ashworth, A. B. Scott, J. E. B. Phelps and H. F. Shearer.

Mr. A. W. J. Stewart drew the attention of the Convention to the fact that Mr. M. B. Hastings, who had been attending, was called away on account of the death of his father, and moved a resolution that the Secretary send him a letter expressing the regrets of the Association. On being seconded by Mr. R. H. Starr the motion carried.

Mr. E. V. Buchanan moved that the Secretary send a letter to each contributor to the programme thanking him. This motion being seconded by Mr. A. B. Scott was carried.

The proceedings of the main session then adjourned.

Concurrently with the sessions of Tuesday and Wednesday, outlined in the foregoing, a Round Table Conference was held for the purpose of discussing accounting and office administration. Mr. D. B. McColl, Manager, Walkerville Hydro-Electric System, was Chairman of the Conferences.

It was moved by Mr. P. B. Yates, St. Catharines, and seconded by Mr. W. E. Wallace, Windsor, that Mr. A. B. Scott be appointed Secretary.

After Mr. McColl had made a few opening remarks outlining the reasons for these Conferences, Mr. W. E. Wallace, Office Manager, Windsor Hydro-Electric System, opened the discussion by introducing the subject of, "Some Phases of General Office Administration."

The discussion on this subject was by Messrs. D. J. McAuley, J. C. Johnston, E. G. Heise, I. N. Pritchard P. B. Yates, Thos. Jackson, D. B. McColl, John S. McKenzie, H. J. Macdonald, R. S. King, and W. G. Hanna.

The proceedings of Tuesday morning then adjourned.

The second session of the Round Table Conference held on Wednesday, July 9th, records Mr. E. G. Heise, Preston, as Secretary.

Mr. A. B. Manson, Manager, Public Utilities Commission, Stratford, introduced a discussion on "Some Advantages of the Mechanical or Machine Billing of Consumers' Accounts." The discussion was entered into by Messrs. D. B. McColl, R. M. Bond, B. Thackeray, A. D. Nelson, H. Clegg, D. J. McAuley,

R. P. Darrell, J. R. McLinden, C. T. Barnes, and H. P. L. Hillman.

Mr. A. D. Nelson, Accountant, Kingston Public Utilities Commission, introduced a third subject on the agenda, viz.: "Operation of Control Accounts in Respect to Consumers' Accounts Receivable."

The discussion following this paper was by Messrs. D. J. McAuley, H. J. Macdonald, J. E. B. Phelps, R. P. Darrell, B. Thackeray, and D. B. McColl.

The Chairman next called on Mr. P. B. Yates, Manager, Public Utilities Commission, St. Catharines, who introduced a fourth subject : "Distribution of Expenses in the Case of Joint Operation of Utilities (such as electricity, water and gas)."

The discussion following this paper was by Messrs. C. T. Barnes, E. R. Shirley, H. P. L. Hillman, H. J. Macdonald, A. P. Manson, Harold Armstrong, D. B. McColl, and E. G. Heise.

The following resolution was introduced :

"Moved by Mr. A. B. Manson, Stratford, seconded by Alderman Armstrong, Belleville,—

"THAT this meeting recommend to the executive of the Association of Municipal Electrical Utilities that a standing committee be appointed to consider matters pertaining to Accounting and Office administration and the joint operation of utilities.

"THAT this committee be composed of a representative from the Engineering and Audit departments of the Provincial Commission and representatives from three or more municipalities, and that this committee be responsible for some item on the programme at each Convention."—Carried unanimously.

The meeting was then thrown open for general discussion, when the following subjects were referred to :

Collection of Consumers' arrears.

Assistance in the interchange between Utilities in the collection of consumers' accounts, where consumers have moved from one municipality to another.

Advantages of machines in billing and compiling statistics.

Cash deposits from consumers.

The discussion on these subjects was by Messrs. D. B. McColl, P. B. Yates, C. E. Brown, J. C. Johnston, A. D. Nelson, D. J. McAuley, H. P. L. Hillman, J. S. McKenzie, C. Thompson, C. T. Barnes, and W. D. Annis.

Before bringing the meeting to a close Mr. McColl, Chairman, thanked the delegates for their interests in these meetings and the various gentlemen who had prepared the papers. He also complimented Mr. R. M. Bond in introducing these sessions at the Convention.

The meeting then adjourned.

At 12.30 p.m. the delegates met for the second Convention luncheon, after which there was entertainment and distribution of prizes.

The register shows a total attendance at the Convention of 369 delegates, as follows :

Class "A"	90
" "B"	118
Commercial	78
Associates	43
Visitors	40

The hotel count of the Convention party was slightly under 600.

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THE BULLETIN

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HYDRO-ELECTRIC POWER COMMISSION
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190 University Avenue
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Subscription Price $2.00
Per Year

Windsor, Essex and Lake Shore Railway Automatic Sub-stations

By H. V. Armstrong, Assistant Engineer, Electrical Engineering Dept., H.E.P.C. of Ont.

THE Windsor, Essex and Lake Shore Railway is an electric line, 36 miles long connecting the City of Windsor to the Town of Leamington and runs through the municipalities of Maidstone, Essex, Cottam, Ruthven and the Town of Kingsville and serves the fertile county of Essex.

This Railway was originally built in 1908 and until this year was operated as a 6,600 volt single phase line, the power being generated by steam, with the power house located at Kingsville.

In 1927 the municipalities which this line serves entered into negotiations with the private corporation to take over this Railway,and in 1929 the purchase was completed and the rehabilitation and operation was put in charge of the Hydro-Electric Power Commission of Ontario.

Owing to worn-out and inefficient 6,600 volt a.c. power equipment and rolling stock and the economy made possible by amalgamating the management with that of the existing Hydro radials at Windsor, the operating voltage of this Railway has now been changed to 600 volts d.c., with sub-stations situated at Maidstone, Cottam and Ruthven, approximately ten miles apart, with Maidstone Station eleven miles from Windsor, and Ruthven Station five miles from Leamington.

These three sub-stations are designed and built for load responsive automatic operation, using the Windsor McDougal manually operated station as the key station.

Each of these three stations are similar in construction and the following description will apply to any one of them.

Each station consists of an outdoor pole structure on which is mounted the 26,400 volt switching equipment, and a brick building for housing the rotary converter and switchboards for the automatic switching equipments.

CONTENTS

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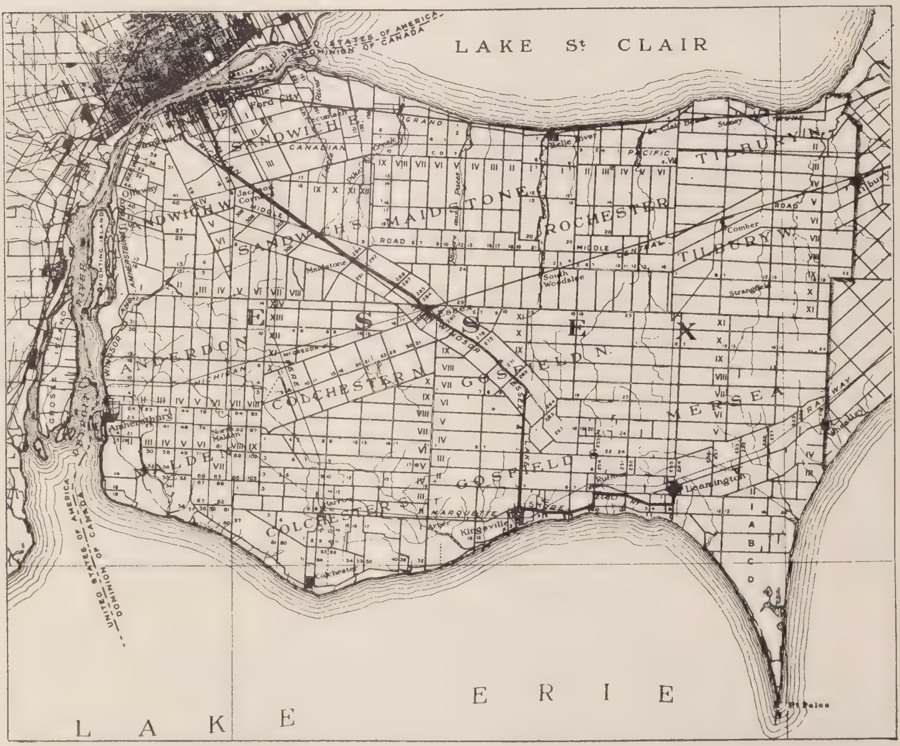
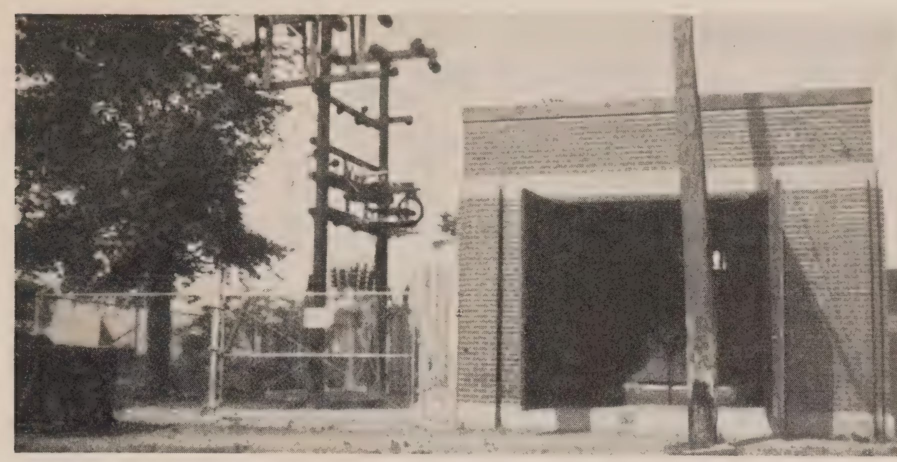
26.4 kv. Switching Equipment

All the 26.4 kv. equipment is placed outdoors and consists of a two-pole structure on which or near which are mounted the oil circuit breaker, air insulated current transformers, the 550 kv-a. power transformer and the necessary connections to same. A 10 kw. control power transformer for supplying 110-220 volt power to the relays for the automatic operation of the rotary converter is connected on the line side of the oil breaker through disconnecting fuse switches. Each station is protected by 26,400 volt, pellet type, oxide-film lightning arresters.

The oil breaker is a Canadian Westinghouse Company type CH-2,



Map of Essex County Showing Route of Windsor, Essex and Lake Shore Railway



Ruthven Railway Substation, showing outdoor high voltage structure and building

600 ampere, 30,000 volt. The power transformer is a Packard Electric Company 550 kv-a., 26,400-13,200/550 volt, 6 phase diametral connected, outdoor type. The control power transformer is a 10 kw. 26,400/110–220 volt, the disconnecting fuses are type EFI supplied by the Canadian General Electric Company. The disconnecting switches and air insulated current transformers were manufactured by the Hydro-Electric Power Commission of Ontario.

Building

The building is of brick construction one storey high, 16 ft. wide and 22ft. 6 ins. long with roof and wall ventilators, and houses a 500 kw., type H.C., Form K, 500 rev. per min., 600 volt d.c., 833 ampere synchronous converter and two switchboards, one being the starting panel, the other the machine and feeder panels.

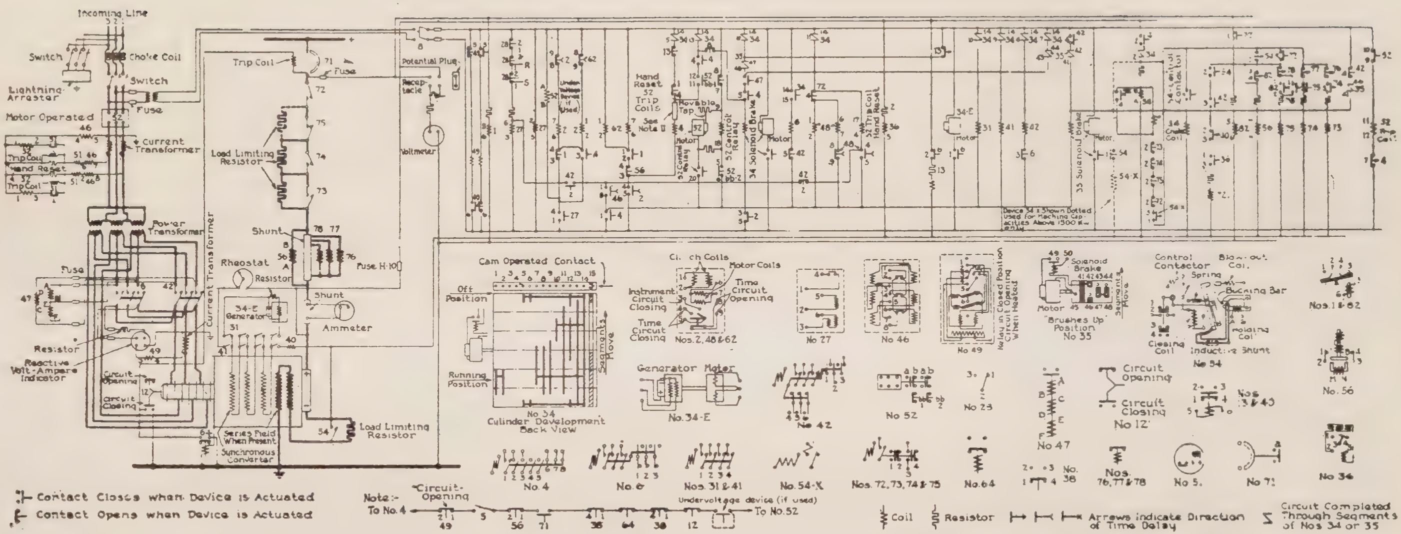
Automatic Switchboard

The starting panel is installed near the wall next the 550 kv-a. power transformer from which the secondary leads are brought directly to it. Mounted on this panel are the starting and running contactors mechanically interlocked and also the field flashing motor generator set.

At right angles to this panel are the machine and feeder panels on which are mounted the necessary relays for the automatic operation as well as the master controller; one d.c. converter panel on which are mounted the machine carbon circuit breaker and rheostat handle; two d.c. feeder panels on which are mounted the main feeder contactors together with the relays for automatic operation of same.

This description holds good for Ruthven and also for Cottam, except for the two 600 volt d.c. feeders. At Cottam the automatic relays for both feeders are mounted on one panel with the feeder contactors supported from the ceiling.

At Maidstone, the automatic switching equipment differs somewhat from that in the other two stations in that the master controller and field flashing motor generator set are combined on a common base and



NOTE.—The "a" auxiliary switches are open, and the "b" auxiliary switches closed, when the main switch to which they are attached is open. The "bb" auxiliary switch is closed when the main switch to which it is attached is open.

Diagram of Automatic Switching Equipment for Synchronous Converters in Railway Service

SEQUENCE OF OPERATION

1. The station is ready to start. No. 8 is closed, No. 27 indicates normal a-c. operating voltage.

2. No. 1 indicates low trolley voltage by closing its 3-4 contacts. Relay No. 2 starts timing.

3. If low trolley voltage continues for time setting of No. 2 and all protective device contacts are closed, No. 4 closes. No. 52 also closes.

4. No. 47 indicate normal three-phase starting voltage. Master switch No. 34 starts.

5. Contactor No. 6 closes and the converter starts. No. 34 stops and waits for the machine to reach approximately synchronous speed.

6. If time from starting of No. 34 to closing of No. 72 is excessive, No. 48 and a hand-reset contact of No. 52 lock out the unit.

7. No. 13 picks up at synchronism and starts No. 34.

8. Field is flashed by No. 31 from the generator of No. 34E.

9. No. 31 opens and No. 41 closes, making the converter self-excited.

10. No. 6 opens and No. 42 closes, applying full a-c. voltage to the machine. No. 34 stops.

11. No. 35 lowers the brushes onto the commutator. No. 34 restarts.

12. No. 54 closes. No. 36 indicates correct polarity. No. 72 connects the machine to the bus. No. 73, 74, and 75 close, shunting the load-limiting resistors.

13. No. 34 stops in the running position.

14. On severe overload, No. 54 opens. No. 72 opens and load-limiting resistors are inserted. No. 54 then recloses, followed by No. 72. When load has diminished sufficiently, No. 82 picks up, allowing load-limiting resistors to be shunted.

15. Underload and high d-c. voltage continuing for the timing of No. 62. Nos. 2 and 4 open and shut down the converter. All devices assume the "off" position.

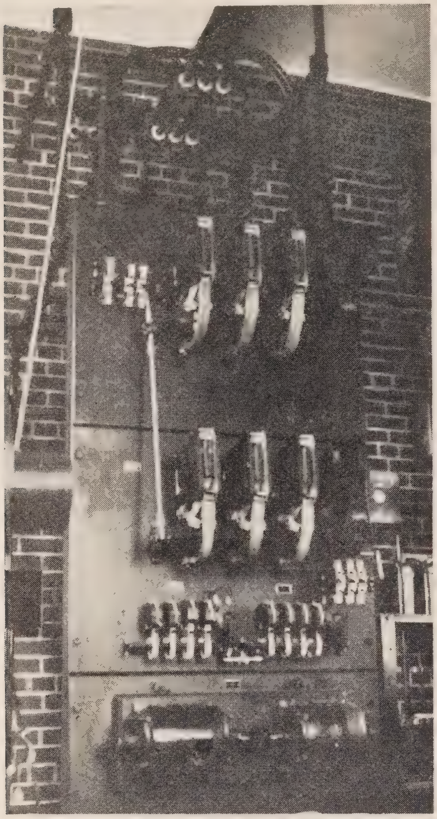
DESCRIPTION OF SYMBOLS

1. Master element.
2. Time-delay starting relay.
4. Master contactor.
5. Manual stopping device.
6. Starting contactor.
8. Control-power switch.
11. Control-power transformer.
12. Overspeed device, hand-reset.
13. Synchronous-speed device.
27. A-c. undervoltage relay.
28. Resistor thermostat.
31. Field-flashing contactor.
34. Motor-operated sequence switch.
34E. Field-flashing motor-generator.
35. Brush-operating mechanism.
36. Polarity relay.
38. Bearing thermostat, hand-reset
40. A-c. machine field relay.
41. Field contactor.
42. Running contactor.
46. Phase-balance current relay.
47. Single or reverse-phase voltage relay.
48. Incomplete-start relay.
49. A-c. thermal relay.
51. A-c. overcurrent relay.
52. Oil circuit breaker and mechanism.
54. High-speed circuit breaker.
54X. Auxiliary contactor for No. 54.
56. D-c. reverse-power and underload relay.
62. Time-delay stopping relay.
64. Grounding protective relay, hand-reset.
71. D-c. line emergency circuit breaker.
72. D-c. line contactor.
73, 74, 75. Load resistor shunting contactors.
76, 77, 78. D-c. overcurrent relays.
82. D-c. reclosing relay.

mounted on a structure at rear of main switchboard.

Operation

With normal a.c. voltage on the line the master starting relay gives indication for starting. Upon load demand the time delay starting relay is energized and if the demand for load continues beyond the setting of the starting relay, this device closes its contacts, starting the motor-driven controller on which are a number of segments which fix the sequence



Starting Panel, Ruthven Station

of starting and stopping operations. With all protective device contacts closed and normal three-phase starting voltage, the starting contactor switch is closed, thus starting the converter. When the machine has come up to synchronism, the field flashing relay closes connecting machine field to 250 volts d.c. and establishing right polarity. The next operation of the controller opens the flashing relay and closes the main field contactor, thus making the converter self-excited. The starting contactor now opens and the running contactor closes, applying full a.c. voltage. The high speed circuit breaker then closes and with correct field and polarity on the machine, which is indicated by their respective relays, the converter is connected through the d.c. line contactor and two sets of load limiting resistors to the d.c. bus. If no overload exists, the d.c. reclosing relay shunts out these resistors and connects machine directly to the bus through the d.c. hand reset line emergency circuit breaker.

If a severe overload occurs under normal operation, the high speed breaker and the d.c. line contactor opens. With the opening of the latter, the load limiting resistors are again inserted. The high speed breaker recloses immediately and after the load returns to normal the d.c. line contactor closes and through the delayed action of the d.c. reclosing relay the load limiting resistors are again shunted out by the load limiting contactors.

When the load is removed from the station and the high d.c. voltage continues beyond the predetermined time setting of time delay stopping relay the machine through the operation of relays is disconnected from the a.c. and d.c. busses and the master controller runs to the "off" position and is then again ready for starting up the machine when required.

Each d.c. feeder is equipped with time delay closing relays, reclosing relay, line circuit breaker and isolating contactors. When d.c. bus and feeder are energized, the isolating contactors are closed and after a predetermined time, the time delay closing relays close and if load conditions are normal as indicated by the reclosing relays the line circuit breaker

closes, connecting one or both feeders to the main d.c. bus.

Protective Features

Each machine is provided with a high speed breaker, a starting protective relay, d.c. overload relay, flashover relay, a.c. overload relays, a.c. under-voltage relay, reverse power relay, overspeed device, polarity relay, a.c. voltage relay, thermal relays and a lightning arrester across d.c. terminals of machines for additional protection against flashovers.

The operation of the flashover relay, a.c. overload relays, d.c. reverse power relay, overspeed device, or the thermal relays (machine temperature and load limiting resistor) will cause a complete shut-down of the station, by tripping out the H.V. breaker. As this breaker can only be closed manually, the attention of the supervisor is required to discover the cause of the shut-down.

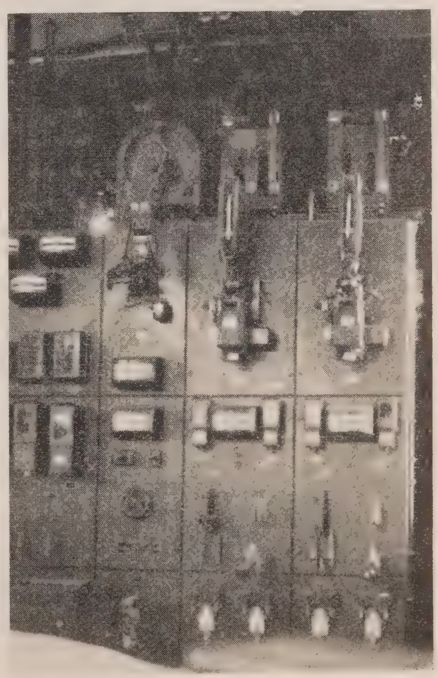
The three-converters, together with the automatic switching equipment for them are of General Electric manufacture.

The time delay starting and time delay stopping relays are of the same design and each has a variable time setting ranging from .16 to 142 minutes.

With both these relays on the lowest setting it takes from 30 to 40 seconds for the machine to deliver power and from 10 to 20 seconds to take the d.c. and a.c. off the machine.

In October, 1929, transmission lines were constructed in order to supply power at 26,400 volts to the railway sub-stations at Maidstone, Cottam and Ruthven. A new line was built from Essex Transformer Station to intersect the railroad near town line between Sandwich West and Sandwich South and this new line followed the railroad to the Town of Essex. Along the railroad in this section provision was made on this new pole line to carry the mast arm, control feeder circuit, and signalling circuits for the operation of the railroad in addition to the 26 kv. circuit. This new circuit intersected the original transmission system of this district immediately south of Essex. To supply power to the railway station at Cottam it was necessary to construct a new line approximately one mile in length, tapping the original circuit in the district.

About two miles south of Cottam where the railroad parallels the original transmission line the latter was



Machine and feeder panels, Ruthven Station

W. E. and L. S. Ry. east of Windsor, showing 26 kv. pole line carrying railway feeder and trolley support with provision for future signal circuits.

rebuilt and co-ordinated with the railway circuits. This reconstruction extended to a point one mile north of Kingsville.

Power was supplied to Ruthven Station by tapping the original Kingsville-Leamington line and extending a short tap to the railway station which is located near the original transmission line.

On the transmission line air break switches were provided at each station connection in order to give these stations the advantage of the transmission loop facilities.

Approximately 19 miles of new transmission line was built for power supply to these stations of which approximately 12 miles were involved in the parallel of the railroad and where joint construction was provided.

The transmission work was started in 1929 and completed during May of 1930.

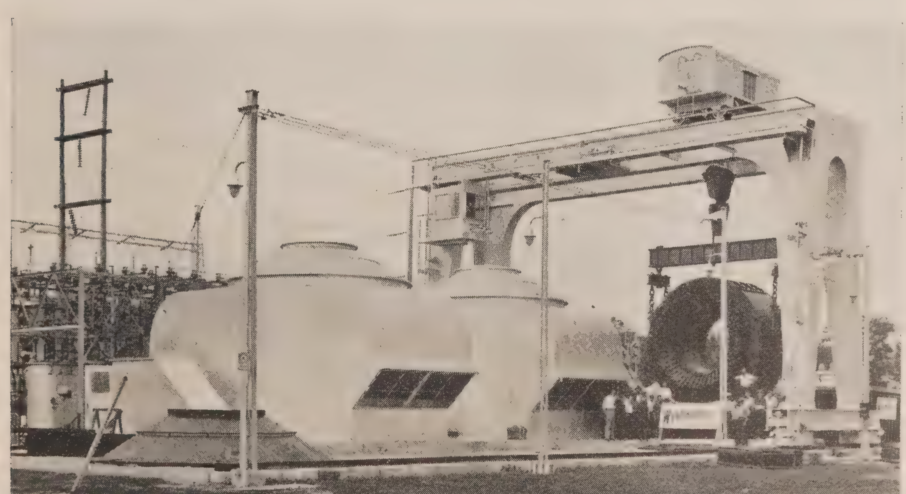
No. 3 Synchronous Condenser for Toronto-Leaside Transformer Station

WE show herewith two recent pictures taken at Toronto-Leaside transformer station illustrating the handling of the stator for No. 3, 25,000 kv-a., vertical, outdoor, synchronous condenser.

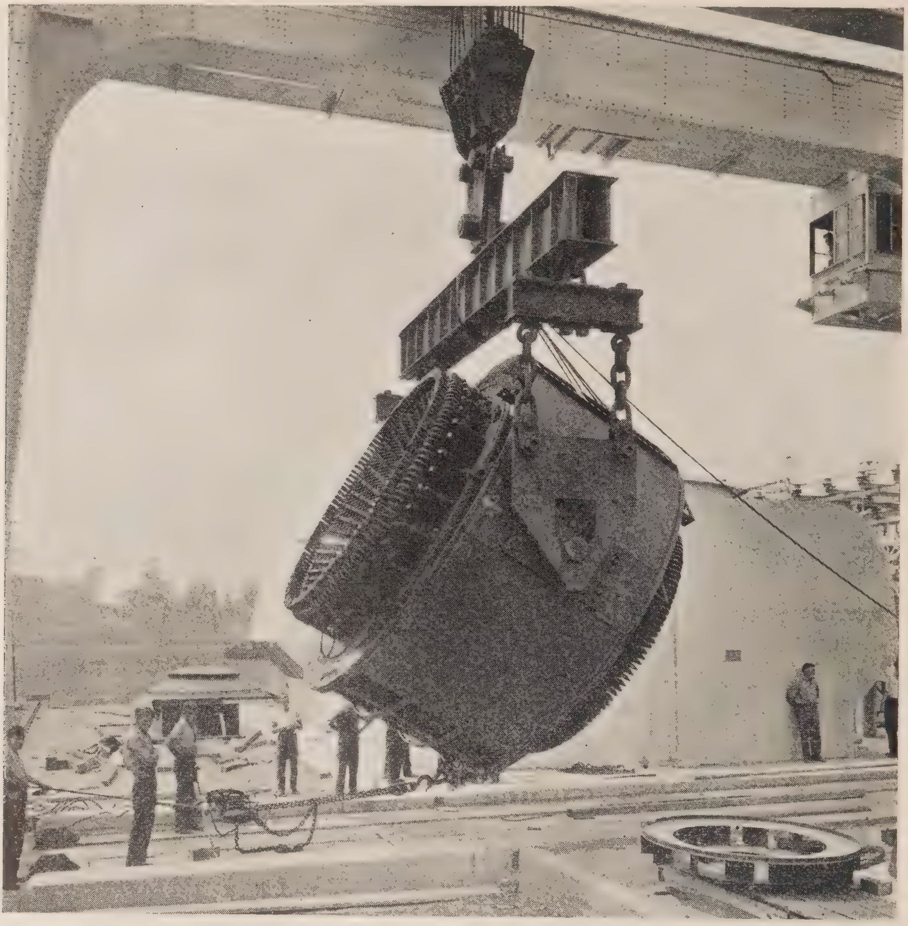
The stator was shipped from the factory to Leaside completely wound. This made it necessary to put it on the railway car on its side, and, due to its width in this position, all traffic on the other track of the double-track railway between Hamilton and Toronto had to be cleared. In one illustration we see the stator immediately after removal from the shipping car. The stator was shipped in the position shown, removable trunnions being bolted on opposite sides to provide means of lifting and turning it. This illustration also shows the completed installation of two condensers already operating.

The other illustration shows the 80-ton stator being turned to its proper position at Toronto-Leaside transformer station site. This shows the removable trunnions bolted on opposite sides of the stator and the stator lifted by the special yoke. A 3-ton pull on the chain block was necessary to turn the stator in the trunnion, the second block at the top being used to stay the stator on turning.

These machines are of special interest, being installed outdoors and having vertical shafts with spherical type thrust bearing below the rotor. The machines operate at 500 revolutions per minute. By means of the



Synchronous Condensers at Toronto-Leaside Transformer Station, showing stator of No. 3 unit immediately after removal from shipping car. It was shipped in this position.



Stator of No. 3 Synchronous Condenser being turned to its proper position at Toronto-Leaside station site.

gantry crane shown in the photographs, it is possible, for maintenance purposes, to lower the rotor with the thrust bearing assembly into the foundation and have the rotor and stator windings accessible in five hours' time, and then be completely protected from the weather. In fact one of the machines shown was completely assembled on the foundations during the winter months without any particular difficulties due to weather conditions.

"The R-100"

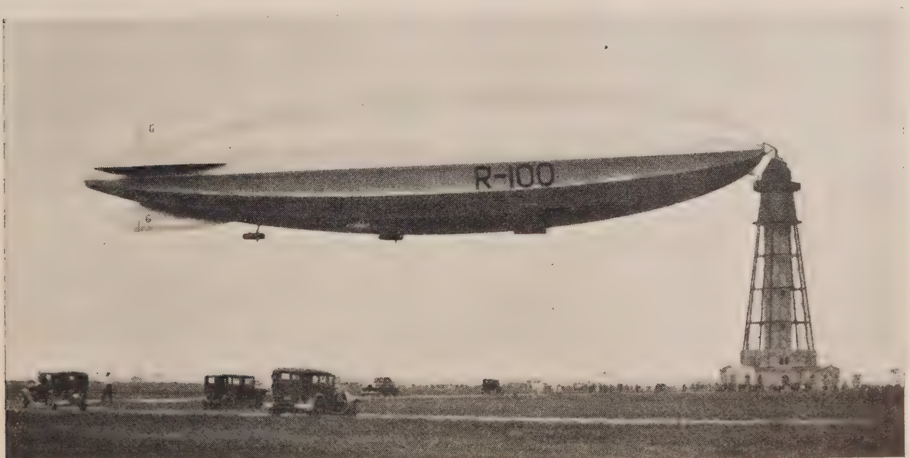
Men, my brothers, men, the workers,
Ever reaping something new.
That which they have done, the earnest
Of the things which they shall do.

—LOCKSLEY HALL.

IT is fortunate for the designers and builders of H.M.A.S. R-100 that they live in the present day as they are not *too* far ahead of their time: Roger Bacon was imprisoned for merely predicting that some day (though it was several hundred years later) vehicles would be propelled without horses!

On July 29th, 1930, this, the greatest airship in the world, left Cardington, England, and headed westward over the Atlantic for her destination near Montreal. Only 78 hours and 51 minutes later the dirigible was moored to the huge mast at St. Hubert as shown in the accompanying illustration which was taken, on August 2nd, by a member of the Commission's staff who had the good fortune to be in the neighbourhood shortly after her arrival. The average speed of crossing was about 43 miles per hour (practically double that of the fastest ocean liners) and even this speed would have been exceeded had it not been for very stormy weather encountered in the Gulf of St. Lawrence and near the city of Three Rivers, which resulted in slow progress and caused rather extensive damage to the fabric covering the starboard horizontal fin. The maximum air-speed of the R-100 is stated to be 83 miles per hour.

The mooring of the ship to the new mast at St. Hubert air-port was carried out very expeditiously, a record being created in this respect over the time taken in England for this operation. For ten days the airship floated at the mast, while repairs to the fabric were carried out and a thorough inspection was made. During the voyage two mechanics performed the feat of effecting temporary



The R-100 moored at St. Hubert air-port near Montreal

repairs to the fabric at night with the aid of a flashlight while the ship was several thousand feet up in the air—this must have been more exciting than erecting steel work at the top of a skyscraper.

Many distinguished people were shown over the airship while she was at the mast.

On August 10th the R-100 left St. Hubert and flew over Ottawa, Toronto, Hamilton, St. Catharines and Niagara Falls, returning to the air-port via Lake Ontario and the St. Lawrence river. Several engineers and other officials of various departments at Ottawa were passengers on this trip and thoroughly enjoyed the experience.

After a short period for inspection and re-fuelling, the airship then left for home. The eastward journey was even more successful than the westward had been, although, contrary to expectation, the time taken was longer owing to rough weather at the other side of the Atlantic. On this voyage several of the more important Canadian daily newspapers had representatives on board : these men, as did all others who journeyed on the ship, testified to her wonderful steadiness and the lack of noise and other disturbing elements which might have been expected.

Many people of Quebec and Ontario had the pleasure and the privilege of seeing this great airship and of noting her immense size which makes details of her design of considerable interest.

Her total length is 709 feet, her maximum diameter 133 feet and her capacity 5,000,000 cubic feet. A good idea of the enormous size of the ship may be gained from the statement that the letters "R-100", painted on each side, are about twenty-four feet high.

The hydrogen gas which gives her lifting power is contained in fifteen gigantic balloonets made of goldbeater's skin. On account of the necessity for using hydrogen, very elaborate precautions are taken against fire and the only complaint heard regarding the ship and its wonderful conveniences was that smoking is absolutely barred.

The outer envelope of the R-100 is 'doped' fabric (similar to that used on aeroplane wings) having a silver finish due to the use of aluminum powder. No less than 225,000 square feet of this fabric are needed to cover the whole ship. The framework consists of about ten miles of thin tubing made of 'duralumin', a very light alloy developed for the construction of aeroplanes. The propelling power of the ship is furnished by six Rolls-Royce 'Condor' type engines, each of 650 horsepower, mounted in pairs. There are several smaller engines for lighting and miscellaneous power requirements. The three engine cars are placed—two abreast of each other about amidships slung to port and starboard of the lower frames, the third further aft, as shown in the photograph.

The ship, as a whole, forms a great floating hotel and is unique in that when fully loaded the total weight is only one hundred and fifty-six tons.

There are two upper decks for passengers, with sleeping cabins, dining saloon, promenade, lounge and balconies; a lower deck serves for the crew. The passenger quarters

are towards the bow, being located where the many windows are seen in the illustration just above the control cabin. Passengers enter the ship at the nose by a 'scoop', shown opening out to the balcony of the mooring mast, and pass down a long corridor to the very comfortable quarters where there is ample provision for observation in horizontal and downward directions.

The personnel comprises the captain, three commissioned officers, coxswains, riggers, fuel-guard, chef, stewards, etc., totalling about forty in all.

The mooring mast at St. Hubert is similar to that at Cardington but embodies some improvements which experience in England showed were desirable. It is about one hundred and fifty feet high and is equipped with elevators. When an airship comes to port, she drops a ground line which is then connected by the 'ground-crew' to another line issuing from the centre of a conical socket at the head of the mast. The line is hauled in until the nose of the airship is pulled right into the socket, which is capable of revolving in a complete circle so that the airship can move into the wind no matter from what direction it may blow. The whole body of the ship is kept in a horizontal position by means of a number of weights (lawn-rollers) which are attached by cables to various points along the hull—as the ship veers with the wind, these rollers travel over the airdrome, somewhat endangering unwary onlookers.

Sir Dennistoun Burney, the designer of the airship, R-100, is already talking of the next airship, which he hopes will be built for regular trans-Atlantic service between England and Canada and says that it should be of 10,000,000 cubic feet capacity, *i.e.*, double that of these first two. There are hints also that a smoking-room may be provided! It is understood from recent paragraphs in the newspapers that the R-100 is being cut into two and that a new section, two hundred feet long, is being inserted; this will make the ship nearly as long as the Eiffel Tower is high and will add materially to her lifting power—no doubt improved stability and other features are objects which the designer has in mind in making this change.

More rapid communication with the Old Country and other parts of the Empire will do much to foster Imperial trade and there can be few Canadians, if any, who do not sincerely hope that within a comparatively few years it will be possible for such great airships to safely and regularly cross the oceans which separate the various portions of the Empire. *Floreat Brittannia!*

F.K.D. and *A.S.L.B.*

The Electrical Hazard in Fire Extinguishing

A SHORT time ago an airplane, as it was about to land at an airport, struck a telephone pole. The pilot lost control and the tail of the plane became entangled with the wires of an electric power line—the nose crashing to the ground. In this way the metal parts of the plane completed the circuit between the wires and the earth and became charged to a potential of 4,800 volts. The pilot saved his own life by leaping from the plane, but his passenger received a fatal shock. The combustible material in the plane took fire, and a mechanic at the airport directed a stream from a fire extinguisher upon the flames. The liquid from the extinguisher served as a conductor for the electric current, however, and the mechanic was killed instantly. A bystander seized the mechanic's feet, with the intention of rescuing him, and he, too, received a fatal shock. The fire continued to burn until all the inflammable material of the plane was consumed, leaving only the skeleton of the ship.

We have no intention of criticising the actions of anyone concerned in this unfortunate occurrence; on the other hand, the mechanic is to be commended for his prompt action in trying to extinguish the fire, and his would-be rescuer is deserving of high praise for his heroic but unavailing deed.

We shall never know whether these two brave men realized the danger to which they exposed themselves, but for the benefit of others who may be called upon to act in similar emergencies, we take this opportunity to speak again of the hazard of discharging streams from hand fire-extinguishers and from ordinary buckets or pails, on electrically charged objects, as well as the peril of grasping or even touching a person who is in contact with a highly-charged electrical conductor.

In *The Travellers Standard* for October, 1924, was described a fatal accident which occurred when a man threw water from a pail about some electric wires, the current from which had started a fire in a barn. This man was instantly killed and two other persons were shocked into insensibility but were quickly revived by proper treatment. The water from the pail had provided a path for the current to flow through the man's body to the ground, thus causing his death. The other persons who approached his body evidently did not receive the full voltage and therefore escaped death. The fatal outcome in the case of the first man was attributed to the fact that when he threw the water on the wires, it undoubtedly left the pail in a solid sheet which could conduct the current to the pail quite efficiently; and as the pail was made of sheet iron and was firmly grasped in the man's wet hands, the conditions for a fatal result were ideally fulfilled.

The conditions are quite similar when using a hand fire-extinguisher, because in order to direct the stream from it effectively the fire must be approached quite closely, and the

extinguishing solution is therefore likely to be in the form of a continuous solid stream. If it were possible for the use of such an extinguisher to stand at a considerable distance from the fire, the stream would break up into a sort of spray, and the air spaces between the various sections of the stream would prevent the free passage of the electric current.

Because of the necessity for approaching a fire closely in order to fight it effectively with a hand fire-extinguisher, it will be well to consider the possible danger of shock when attacking electrical fires with these first-aid appliances, using various kinds of extinguishing solutions.

The simplest form of extinguisher is a pail or bucket containing plain water, or a solution of water and calcium chloride or some other substance employed to prevent freezing. Under ordinary conditions water is a more or less effective conductor of electricity, and we have just described a fatal accident resulting from the use of it for fire extinguishing. The addition of calcium chloride or any other mineral substance, does not reduce the conductivity of the water in which it is contained, but usually increases it.

The various kinds of commercial hand extinguishers* in common use employ :

(*a*) soda-and-acid solutions,

(*b*) substances which produce foam

(*c*) solutions with a carbon-tetrachloride base,

(*d*) compressed carbon dioxide.

The soda-and-acid solutions are good conductors, and are therefore dangerous to use in fighting fires where charged conductors are involved. Foam streams are also electrical conductors to some extent, and therefore are not recommended for use on fires involving high-tension electrical apparatus.

Carbon tetrachloride and carbon dioxide are non-conductors and may be used without danger of electric shock. Carbon-dioxide extinguishers are specially appropriate for use when fires break out about costly electrical machines and apparatus, not only for the reason that carbon dioxide is a non-conductor but also because it dissipates quickly and in itself does no damage to the equipment.

The hazard here under consideration may seem to be rather remote and yet, as in the two cases cited, it may arise when least expected. Therefore all reasonable precautions should be taken to avoid the danger. It is of the greatest importance, therefore, to shut off the electric current before attacking the fire, if this can possibly be done.

As a general rule, it may be said that there is little likelihood of injurious electric shocks from the cause here being considered, when dealing with potentials of 600 volts or less. It is advisable to exercise all possible care even with these voltages, however, and correspondingly greater caution is required at higher potentials.

* It should be remembered that in this article we are considering chiefly the use of hand extinguishers, which are valuable only in dealing with fires in their early stages. If a fire has gained considerable headway, water or some other extinguishing agent must be used in large quantities, regardless of the fact that the agent may be a conductor of electricity. The operation of automatic sprinkler systems involves no personal hazard of electric shock, however, and there is little danger in the use of hose streams when applied by experienced firemen who are provided with suitable equipment and know the precautions to be taken.

Another lesson to be learned from the tragic occurrence described at the beginning of this article is the danger of touching a person who is in contact with a live electrical conductor. This does not mean that such a person is beyond help, but it is highly essential for anyone who tries to break the contact to take certain precautions in order to avoid injury. The obvious and safe thing to do is to cut off the current immediately, if there is a circuit breaker or switch near by. If the line is still "alive", however, neither the victim nor the conductor can be safely touched with the bare hands so long as the rescuer himself is in contact with the ground or with any object or material through which the current might pass to the ground. In many cases it is easier to move the charged object (usually, a wire) than it is to change the position of the victim. A stick of *dry* wood or the *dry wooden* handle of a tool may be used for the purpose, and if possible a *dry* board should be laid down on which the rescuer may stand; or he may take hold of the victim's clothing, or may grasp his body if he first covers his hands with several thicknesses of *dry* cloth, or with rubber gloves if they are available. If the accident occurs inside a building and the rescuer can stand on a *dry* wooden floor, he may pull the victim away from the conductor without serious danger to himself.

In conclusion, it may be of interest to consider the possible danger to a fireman when directing a stream of water from a hose against a high-tension line or against objects in close proximity to such a line. A few years ago F. C. Caldwell, professor of engineering of Ohio State University, conducted a series of tests which seem to settle the matter quite definitely. His conclusion was to the effect that under normal conditions the fireman is unlikely to receive a dangerous shock, provided the nozzle of the hose is at least 25 feet from the wire, because at that distance the stream will be broken up to such an extent that it will no longer serve as an effective conductor for the electric current.

The tests referred to were in connection with a 30,000-volt line on which a stream of water was played from a nozzle 1⅛ inches in diameter. The accompanying table shows the amount of electric current that was registered at the nozzle after having been transmitted over streams of water of various lengths, and the resistance offered by the water.

Length of stream (feet)	Resistance (ohms)	Current at nozzle (amperes)
8	70,000	.43
12	100,000	.30
16	135,000	.22
20	200,000	.15
22	430,000	.07
24	770,000	.04
26	1,100,000	.03

Although a current of at least one-tenth of an ampere (and probably considerably more, in the average case) is necessary to cause death, as little as .02 of an ampere is quite painful, and a current of .05 of an ampere is almost unbearable. It is therefore possible, under certain conditions, for dangerous shocks to be received from hose nozzles by firemen

who are 20 feet or less from an electric conductor with a potential of 30,000 volts, and for the current to make itself felt in a highly disagreeable manner at considerably greater distances. However, firemen are trained to take all possible precautions in fighting fires involving electrical apparatus, and the rubber boots, coats, and hats which they invariably wear provide considerable protection. For these reasons it is seldom that a fireman receives a severe shock when playing a hose on a charged wire.

—*The Travellers Standard.*

Cable Notes

By *Simplex*

Road repair:
Navvy, pick;
Cable there—
Dying kick!

Junction box,
Jointer's mate;
Sudden shocks—
Heaven's Gate!

Engineer,
Spanner, flash;
Urn and Bier—
Calcined ash!

Glover's Almanac, 1905

Window display, Kitchener Public Utilities Commission

Merchandising of Domestic Load Builders by Public Utilities

By George W. Hague, Campbell-Ewald Limited, Toronto

(Read before Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 9, 1930)

EVERYONE to-day is interested in selling something—even those who do not look upon themselves as being engaged in selling. You who are gathered here to-day may, perhaps, consider yourselves as technical men—experts in a certain branch of science—rather than as salesmen. And yet, whether you like it or not, you *are* salesmen. Your professional success is dependent upon the progress of the electrical industry—the continued and increasing use of electrical power. You are consequently interested in the growth of consumption of electrical power—intimately and acutely interested in it. You do what you can to promote the distribution of power. You may do this by actually soliciting customers, or you may do it merely by providing such excellent service for existing customers that others will want their homes wired. Whichever your method may be, you are salesmen. And, I may add, as salesmen you have been doing a remarkably good job in this province of Ontario—one which is helping to keep the eyes of the electrical world focussed upon the province. Both as salesmen and as technical experts, I know you must be proud of the job you are doing. But for the same reason I feel certain that you will be interested in taking advantage of every opportunity for keeping Ontario several jumps ahead of the rest of the world in its use of electric power.

I am assuming in all this that the primary interest of everyone present is the distribution of an increasing volume of power. And because that is your primary interest, I propose to talk to you to-day about the distribution of an increasing volume of electrical appliances.

You may be inclined to wonder why I should presume you to be interested in one thing and proceed to talk to you about a totally different thing. Probably that needs a bit of explanation.

There are two main sources of demand for power—commercial and domestic. It is the second of these—the residential or domestic demand—with which I have to deal.

In building domestic load there are just two sources of increase. One is more consumers, more meters ; the other is more use by existing consumers, more current through the meters which are already installed.

The addition of more consumers is important—so important that somebody who knows more than I do about that phase of load building will have to tell you about it. The increase of consumption by existing consumers, however, is no less important, and I want to ask you to think of it more seriously than you have ever done before.

That is the particular phase of load

building with which I have to deal; the increased use of electrical current through existing domestic meters.

At the present time I feel safe in saying there is only one means by which this particular variety of load-building can be achieved, and that is through the purchase and use of more electrical appliances by existing consumers. Notice that I say "at the present time."

In some future era when there are half a million ranges, or water heaters, or washing machines or what-not in use in Ontario, the big idea may be to popularize new recipes which will require more minutes of cooking ; or to invent new quantity uses for hot water; or to obtain universal acceptance of the theory that a complete daily change of clean body linen is a universal necessity for self-respecting humans. That plan of salesmanship may be the big idea some time in the future. But just now, with only a quarter of the wired homes possessing electric ranges or washing machines, and only a twelfth of them owning water heaters, I think it is safe to say that the only practicable means of load building in existing wired homes is through the sale of *more* appliances.

By now, of course, you will have realized what I meant in saying that *because* you were interested in selling power I was going to talk to you about a totally different matter—selling appliances.

Yet *is* it a totally different matter? As I have pointed out, the sale of appliances is practically the only means by which, at the present time, more power can be sold to existing wired homes.

I think you will concede that much to me. What you may still be doubtful about is the importance of this method of increasing the total domestic load.

As to that, probably the most convincing example of what can be done is found in the record of what you have already done. Not what somebody has done down in the United States or over in China, but what you electrical men have done right here in Ontario.

Taking the years from 1924 to 1927—the latest period for which I have been able to find complete figures on both sides of the comparison, there was a very substantial percentage of growth in the numbers of appliances in use in the province. Totalling fifty representative Ontario towns and cities, we find that the total increases in appliances vary from 310 in the case of ironers to 27,390 in the case of ranges. However, looking deeper we find that the increases in saturation points of seven of the principal appliances vary only from .3 per cent. to 10.9 per cent. We find further that after this increase the highest point of saturation in any of these seven was only 12.5 per cent. On an average 87.5 of the wired homes had still to be equipped with these important appliances.

But looking still deeper, we find that the average *increase* in saturation for this group of seven during the three years in question was only five per cent. A very small increase, one would think. Nothing to cause excitement. Nothing to accomplish much in the way of load-building. In other appliances, during the same period, the increase was hardly more remarkable. If they all were included the average increase in saturation would still be only about five per cent.

Possibly a little less. Nothing at all remarkable—on the surface.

But here is where that small increase becomes remarkable: when you compare it with the increase in current consumption per meter during the same period.

In 1924 the average monthly consumption per meter was 80.2 kw-hrs. I think we have already agreed that the only way to increase this average for existing users lies in their use of more appliances. So we must think of that small increase of 5 per cent. in the average saturation point of appliances when we note that by 1927 the average monthly consumption of current had jumped to 103.5 kw-hr. In those three years the average domestic current consumption grew from 80.2 kw-hr. to 103.5 kw-hr. per month—an increase of 23.3 kw-hr.—an increase of 30 per cent. in the average domestic current consumption—an increase of 30 per cent. in the actual gross domestic current consumption by old customers alone! Thirty per cent. more domestic power sold by virtue of increasing the use of electrical appliances only 5 per cent. of saturation!

Let me say further and in a more general way that you can go on at that rate of saturation progress for approximately another twenty years before you reach the actual saturation point in existing appliances. And of course by that time there will be dozens of new appliances for purposes not yet dreamed of. But in existing appliances alone you could go on at that rate for about twenty years before reaching saturation; and in the process you would be increasing the domestic consumption of current approximately 200 per cent. without adding one new consumer to the system.

Surely, in view of that, you will find it possible to agree with me that one of the most effective means at your disposal for domestic load-building lies in the sale of more and more electrical appliances. You yourselves have proved its efficiency in your work here in Ontario. They have done good work in the United States also. There they increased the average wired-home demand from 400 hours per year in 1926 to 500 hours per year in 1929. But in the three years from 1924 to 1927, you, here in Ontario, had increased the load from 962 hours to 1242 hours per year, and I believe the present figure is roughly 1500 kw-hr.—three times the consumption of the average American home. Yet, even so, we have only scratched the surface. We have only an average of 12.5 of saturation in seven of the most important appliances, including several moderatley inexpensive ones. There is all the opportunity in the world for keeping Ontario far in the lead in domestic electrical use. Indeed, with prevailing current costs averaging less than one-quarter the corresponding rates south of the line, there would be no excuse for us failing to keep well in the lead in our domestic use of electricity.

However, there is another aspect to the problem of domestic load-building, and that is the problem of economics. As I am not a technician, anyone of you could tell me a lot more than I could tell you concerning the uneconomic influence of peaks and valleys in the diurnal and seasonal consumption of power. When the watt demand is high in proportion to

the annual kw-hr. of consumption, the supply of current is naturally less profitable than when the demand is low and the consumption high. This general fact is illustrated in intimate detail in the following chart.

However, I want particularly to avoid any discussion of the relative merits of this appliance or that, from the standpoint of the vendor of power. One reason is that for each of you the problem is a different one—different peaks and valleys, due to different circumstances, in your respective communities. But my principal reason for asking you not to bring this into the discussion is that it would be based on a complete misconception of the whole point of this address. For what I want to register is this : that in spite of the data on the chart which you have just seen, all appliances are good appliances from an economic load-building standpoint—*if you sell a lot of them.* That is the one, outstanding condition to any profitable sale of electric power—number of users.

Let me illustrate that in the case of just one variety of appliance in which the data was gathered by an actual observation of results. The unit demand in this case was 3.61 kw. That was with only one installed. With 80 installed in the community the theoretical kw. demand would be 80 times as great, for the very simple reason that the eighty users never had this appliance operating in all of the eighty homes at the same time. In the case in point the actual kw. demand per unit decreased from 3.61 kw. to 0.80 kw. as the number of users increased from 1 to 80.

Further, it is similarly true that units of differing natures help to offset one another's peaks and valleys. Mrs. Jones switches off her toaster

APPLIANCE REVENUE DATA

from

McGraw Hill Co. ~ adjusted to a 1¢ rate

APPLIANCE	WATT DEMAND	ANNUAL K.W. HOUR CONSUMPTION	RATE PER K.W.H	ANNUAL REVENUE	ANNUAL REVENUE PER K.W.H. OF DEMAND
Heater	600	42	1¢	42¢	70¢
Toaster	500	37	1¢	37¢	74¢
Washing Machine	300	25	1¢	25¢	83¢
Percolator	400	42	1¢	42¢	$1.05
Iron	600	72	1¢	72¢	$1.20
Vacuum Cleaner	200	27	1¢	27¢	$1.35
Fan	50	16	1¢	16¢	$3.19
Oil Burner	300	265	1¢	$2.65	$8.85
Range	2500	1500	1¢	$15.00	$6.00
Refrigerator	300	725	1¢	$7.25	$24.16

and percolator, and turns on the water heater. When the dishes are washed she vacs the rugs ; then perhaps has a washing or ironing to do. Then the stove goes on for luncheon. Later the water heater again for dishes. These done, an air heater or electric fan may come into play to temper the atmosphere to a point suitable for afternoon lounging. And so it goes throughout the day and a good part of the night. Multiply Mrs. Jones by one thousand, each with a different domestic schedule, and the performance becomes almost a perpetual one. The more Mrs. Joneses, the better. But the more appliances of varying sorts which each of them has, the flatter the peaks and valleys and the more certainly profitable the sale of electric current.

Consequently the present problem is not at all a problem of *which* appliance you should sell in your community. Generally speaking you should sell *all* appliances in *any* community—as many of them as you can sell, and of as many different sorts to as many different customers. In the mass they are effective peak-levellers. It is needless, in fact misleading, to attempt to discuss the merits of this or the demerits of that from an economic load-building standpoint. The present discussion concerns appliances in general, and of these it can truly be said that they are ideally efficient as load-builders and profit earners.

If it is conceded that appliances are the only means of load building among existing domestic current consumers; and that they are a prolific source of increased load ; and that they are an economic source of increase; you may still be asking questions :

First, is it desirable for the public utility to operate as a merchant ?

Second, is it possible by deliberate effort to make any appreciable increase in appliance sales ?

Third, what forms of deliberate effort should be adopted ?

Up to this point I have gone on the assumption that you are all operating stores. Actually, of course, there are some of you who are not. I am not going to be dogmatic in saying that you all *should* operate stores. But I can say at least that there is no reason at all why the public utility should *not* operate a store. Often the fear of hurtful competition with existing retail merchants has caused public utilities to hesitate in opening stores. It should not do so. The common experience has been that where the utility has opened and operated a well conducted retail establishment, other dealers in electrical appliances have benefited. Not only have they not been hurt by the "competition"—they have usually been actually benefited by the stimulus which the utility's store has given to the demand for appliances.

In many localities the sale of electrical appliances is more or less of a sideline venture with electrical contractors or with merchants whose main line of commerce is something quite unrelated. Such merchants naturally do very little to develop a market for appliances. One reason is that such business is only a side issue with them. Another reason is that frequently they are unversed in

the technical knowledge necessary in the sale and servicing of such goods. In the case of electrical contractors, often they lack the premises, the organization, the time and the patience to make them successful merchants of appliances.

Usually when the utility opens its own highly specialized and well conducted shop, the demand for the merchandise it stocks is so stimulated that competitive merchants benefit, almost from the start. Possibly they may not admit it. But I think that usually it is the case. Part of the reason for their benefit is that their own selling activity increases when they see a new shop making a specialized bid for the business.

However, there is nothing at all mysterious in the benefit to general business from the opening of a utility store. I imagine that most of you are operating in an actual effort to co-operate with the other merchants to the fullest possible extent. That is the correct line of operation, for it is the line which will eventually develop the greatest sale of appliances and the heaviest consequent consumption of electrical energy.

And now for the question as to whether it is possible, by deliberate effort, to make any appreciable increase in appliance sales.

There cannot be the slightest doubt of it. Over in St. Catharines the store of the Dominion Power and Transmission Company sold to its 1050 customers in the course of a year electrical appliances totalling $26,739 in value, an average of $25.66 to each customer. Perhaps you will say that is because St. Catharines is a very old electrical centre. Very well, then look to Rouyn. The 562 customers of Northern Canada Power in that *new* town bought an average of $24.14 worth of appliances, each, in a year. And similarly, down at the other end of the list we find both old power towns and new power towns where the sales average only four or five dollars a customer. The list I am referring to is one published by the Electrical Dealer and Contractor. At the top of the list we find stores at Knowlton, St. Joseph and Kirkland Lake whose sales per customer amounted to averages of $61.82, $53.78 and $40.04 respectively.

I do not mean to suggest that selling effort will make all the difference between four dollars a customer and sixty dollars a customer. But I do contend that it must make most of the difference. And I contend further that the utility which keeps its sales around $60 a customer for several years is going to sell a lot more power per meter and have its peaks and valleys of consumption flattened out a lot more than the utility which maintains an average of only four dollars a customer in appliance sales. It would be an interesting experiment if all of you were to report your appliance sales per customer for the next five years, and then, at that time, compare the records with the contemporary growths in domestic loads, and with the rate of revenue shown per kilowatt of demand. The result would, I feel sure, make all of you enthusiastic appliance salesmen.

But it should not be necessary to wait that long for this result. The logical outcome of such a test should be pre-evident to men technically minded.

Finally, then, we come to the question of what forms of deliberate effort

should be used to bring increased appliance sales.

First I want to mention one form which I think should *not* be used, and that is price-cutting. Keep in mind that what you are interested in is in getting more appliances into use in homes. Usually, a thorough-going job in this direction requires the combined selling efforts of other stores besides your own. If you set a good merchandising precedent for those other stores, you will all sell more appliances. But if the precedent you set is one which they cannot profitably follow, then the result is apt to be the sale of fewer appliances. So adopt for your store a policy which would be a sound and profitable policy if you were dependent on appliance sales alone for your revenue. Make the store pay a fair profit. Set an example which the other merchants will want to follow. Get them all working as hard as yourself for the appliance business. Possibly, for some of you, the best method of achieving this might lie in keeping only a public display shop, sending customers to the other merchants for the actual sales. But usually there is little point to operating the display without making the sales.

Aside from price-cutting, I think it has been proven practicable for the utility appliance shop to make use of every legitimate form of merchandising effort.

Have a prominent central location. This will add materially to the selling force of your display, and it will also help to encourage people to call to pay their bills instead of mailing payments.

Have the receiving cage at the rear of the store, so that customers will have to pass the entire interior display to reach the wicket. Many good sales originate in this manner.

Maintain always, in every corner of window and store, an appearance of spotless cleanliness and neatness in harmony with the clean, vital nature of your principal commodity—electric energy.

Go to considerable pains in window dressing. Your windows are valuable. The United Cigar Store organization, whose operations prove that it knows more about property values than any other similar body, estimates that the shop window area represents 80 per cent. of the rental value of the entire store. If you get that idea firmly implanted in your mind, you won't have to do any arguing with yourself about how much attention you should give the window display. There is a wealth of display material available from manufacturers. It costs money. Sometimes big money. And it is worth big money if intelligently used. Use it. Store it where it will be safe from injury. Then use it again in a somewhat different set up. Make it work for you. Use electrical signs of all sorts. They will not only help to sell the goods they advertise but will help to sell the use of such signs to other merchants ; more commercial load for you.

Then the interior. See that the layout of the shop gives the maximum of display. Don't crowd the display. Avoid duplicates of an appliance. Instead of duplication, get the utmost of variety into the interior showing of merchandise, at the same time avoiding crowding or clutter.

If space is limited reduce even the variety shown.

If possible, two or three comfortable chairs should be grouped on a rug, encouraging unhurried consideration of appliances and promoting the successful conclusion of large item sales.

Train your salesmen to keep the appliances displayed as spotless as the store. I believe this usually is done, but it is so important that I must not omit to emphasize it.

Advertise persistently in your local newspaper. Be particular about your advertising. If its appearance is not as bright and smart and interesting as the best in the paper, keep after the newspaper or the man who prepares the advertisements until it has the appearance you want. Then keep on keeping after them. Your advertising should be in harmony with your business—which is the smartest, most modern business in all this modern world. Tie in with the national advertising of electrical appliances. Every week some of it is appearing in your local paper. Make it work for you to sell more appliances to consume more power.

And then, most important of all, there is the salesman. Engage only men and young women whose appearance is harmonious with the high standard of your business and whose intelligence is equal to mastering its technical aspects. Teach them everything they need to know about the appliances. Turn the manufacturers' salesmen loose on them to coach them on the selling points. See that they read all circulars and advertisements concerning the goods they sell. Nothing will kill a sale quicker than a salesman's ignorance on some simple question concerning the merchandise he is showing. Salesmen who "know their stuff" sell three and four times as much as those who don't. This only means that the weak ones are losing three sales out of every four they might make. Ignorance of the product can be ridiculously costly to the business.

In keeping with modern selling methods, it would be advisable for you to consider the employment of a force of outside salesmen. This actually is one of the most prolific sources of "created" sales—that is, sales developed among customers who had had no serious thought of purchasing. Such salesmen must be even more rigorously coached than those on the floor. They must know not only the merchandise but the theory and practice of "opening" and "closing" a sale with an unintending purchaser. Yet the problem of training them is not insuperable. In many places comparatively green men have quickly become prolific business builders.

All the foregoing has to do with merchandising the goods. But you must do—and most of you are doing—considerably more than that. You are a public utility, very much in the public eye. Your success in many things depends on the opinion the public forms of you. Its opinions are formed from many things—so don't overlook any of them. Courtesy ALWAYS. That goes a long way. Smartness and cleanliness of appearance of your premises and staff—these are necessary because they are the visual representations of the utility itself to the eye of the public.

Accuracy—it begets trust. Promptness and competency in service—it develops a public belief in the efficiency of your whole organization.

These things have an overwhelming influence when, as frequently happens, there comes the occasion of a public vote on a question of vital importance to the utility. If you have given a good impression in everything, you are given your will in the vote. But otherwise——

Partly from this standpoint of public deference and partly from strictly commercial considerations, you have to face a buying problem which the independent merchant or electrical contractor does not have to face to the same extent. It is the question of the quality of the goods you buy for sale. Now as a general principle, the purchaser gets just what he pays for. If the price is low the value is low. The consumer, even though he complains of the result, knows this in his heart. But when he purchases from a public utility he somehow expects the value to be high, whatever price he pays. Nothing can be more ruinous to your reputation than the failure of the goods you sell. Individual grudges thus inspired may involve amazingly disproportionate and embarrassing consequences for the public utility, subject as it is to the whim of a bare majority of townsfolk. Quality products only, would seem to be your surest protection. Leave the price competition to the independent merchant for whom the risk is not so serious.

But there is another reason for your concentration on quality products. As I pointed out in opening, your principal concern is the sale of electric energy. So, when you sell electrical appliances, be sure they are of a sort that will continue to use electric energy. The cheap appliance fails to promote the use of power for three reasons—first, because it is often temporarily out of commission ; second because it is sooner to go permanently out of commission, and may not quickly be replaced ; third, because it is less satisfactory in service and consequently is given less use than a thoroughly efficient appliance would receive.

It would seem to be good common sense for the utility to merchandise only nationally advertised and fully guaranteed appliances, of whose quality it could feel assured, and manufactured by companies with reputations to maintain. Merchandising such lines will go far toward building the reputation of the utility, reducing its service problems, and ensuring a constant, dependable revenue from the use of the appliances after they reach the home.

Discussion

Mr. W. B. Buchanan, H.E.P.C. of Ont.:

Mr. Chairman, there is one point, if it has not already been mentioned, that should be put on record. Merchandising appliances may possibly bring in to question the effect upon radio interference. I know one large Company which makes a practice of making regular tests of all apparatus which they sell with that in view. But at the present time there is a sub-Committee from the Canadian Engineering Standards Associa-

tion giving some attention to the presence of radio interference, and it is possible that this may be a rather live problem in connection with appliances in the future.

Mr. A. J. W. Stewart, Toronto:

Mr. Chairman, there is a side-light on this question of selling appliances that I think could very well be referred to here, and that is the question of proper wiring. Those who have been interested in the selling of appliances have found that the lack of proper wiring often prevents a sale. Also, after the customer buys a toaster or percolater or some table appliance, if they have to climb up and attach it to a lamp fixture to make toast or coffee, you will not get the revenue from appliances that would otherwise come. I have some figures here that were taken from a check-up of about 100 Red Seal houses in Toronto and a corresponding number of houses in the same price class, but not as good wiring. I won't read all of these, but a few are interesting. They are as follows:

	Red Seal Houses	Other Houses
Ranges	98	20
Water Heaters	77	11
Radios	78	11
Irons	104	100
Ironers	15	3
Refrigerators	52	7

It shows quite clearly that the houses with proper wiring use far more appliances. A check-up was also made of the value of the appliances in those houses. In the houses with the poor wiring the retail value of the appliances exclusive of the wiring was about $269.00; in the others, $670.00, or 150 per cent. more potential sales in addition to the extra power used.

Mr. E. M. Ashworth, Toronto:

Mr. Chairman, I would like to add a word to what Mr. Stewart has said about the Red Seal. Of course, we are all in a somewhat different position from the employees of the public utilities that are privately owned. Our object in life is not to make money—it is to give service. It is true, as Mr. Hague says, that we should try to sell all appliances that are convenient. We have to consider the question of the cost to the public of the power that we sell. We all know, for example, that an electric range is used seven days a week and fifty-two weeks in a year, and generally off peak, whereas, take for example, the air heater, which is used at such a time as to increase the cost to the local Hydro and that is reflected naturally if there are an excessive number of undesirable appliances of that sort. Finally, it is reflected in the rates for power, so that we should exercise some discrimination in recommending appliances to the public. At the same time, our real duty is to educate the public to the advantages of using electricity. We should never consider that we have reached the saturation point so long as there is a woman in our municipality who still irons with a sad iron or sweeps with a broom, or scrubs her clothes over a washboard. Our duty is to try and induce the time-saving and labor-saving and health-saving devices that electricity makes possible. Of course, in the electrical industry there are three main branches. There is the current

supplying branch, which we represent, the manufacturing branch, which is represented by the manufacturers and jobbers, and there is the construction branch which is represented by the contractor-dealers. We should all co-operate in the work of increasing the utilization of electricity. A question arises to what part of the task of increasing the use of appliances we, as public utilities, can best apply ourselves. Now, I feel that, in advertising appliances and pushing their sales, the manufacturers, jobbers and dealers have the advantage of position. After all, when you come to sell a washing machine, it is very nice to be able to say, "See all the beautiful points of this particular washing machine. It has such-and-such contrivances, and such-and-such advantages of appearances," and that is something a manufacturer can do. He is selling some specific appliance and he can bring out all the selling points and make the sale. And when I say the manufacturing interest, I mean right down to the dealer. But the utility has to exercise discrimination. After all, it is a little bit doubtful when a utility ties itself absolutely to one make of appliance. It is, of course, open to a certain amount of criticism, so that I feel, in the actual selling of the merchandise, the manufacturer and jobber and dealer have the advantage. But I do think, as Mr. Stewart points out, that the branch of the propaganda where we are in the most advantageous position to carry on is the promotion of better wiring. It is something like the growth of the automobile industry. I don't know if you ever figured out how the increase in the use of automobiles has followed from the construction of good roads, and how the construction of good roads has followed from the increase in the use of automobiles; so that those two branches of the industry are like two hands washing one another. They tend to build each other up, and, in the same way, the place of the utility, to my mind, should be devoted very largely to the promotion of better wiring, which will, in turn, cause the use of more appliances and the more widespread use of appliances will cause the installation of better wiring, and you get the same co-operation between the two sides of the business in that way. You know, after all, a range, for example, is no more use to a woman who has not the wiring for a range than a sewing machine is to a blackfoot squaw. She cannot use it. Now another thing. The municipal Hydros each have their own field, and the advertising they should do is that which is more effective in their own field, and we feel, for example, in Toronto, that, when we advertise a standard of better wiring represented by the Red Seal, we are not wasting five cents of that advertising; it is all going directly to our own constituency; that is, information in regard to the Red Seal distributed and circulated through the Toronto papers is circulated just where it will do the most good. Now there is another point. The average man or the average woman is not interested in wiring at all. You go round trying to get people who are already occupying houses to put in a little more wiring, and you cannot interest

them a bit. They might like a receptacle in the living-room, perhaps, or in the dining-room, but, apart from that, they are hardly interested. Any sales effort you spend on them in the promotion of detailed information in regard to better wiring is largely lost. But there is one time when every one is deeply interested in the subject of wiring, and that is when they are buying or building a house; and, if you can educate them to the fact that there is a certain established standard of wiring and that it is represented by a certain symbol, the Red Seal, that much will stick in their minds, and, when they go to buy or rent a house, they will inquire if it is Red Seal or not. That is our experience in Toronto. The success of the educational work there is evidenced by the fact that we are getting between eighty and ninety per cent. of all new houses and apartment houses in Toronto wired for Red Seal, which means they can take an electric range or an electric water heater. Another thing, if you establish a standard like that, and induce a speculative builder to spend the money to wire his houses up to that standard, he becomes a salesman for you. He is your distributor. He is like the grocer who has bought Campbell's soups and puts them on his shelves—he wants to sell Campbell's soup. This speculative builder has paid the money to put Red Seal in his house, and therefore he wants to sell Red Seal, so that the whole set up is a very sound merchandising proposition.

Mr. A. B. Scott, Galt:

I would like to ask Mr. Hague whether he considers it good policy for a utility to handle more than one line of a certain article. That is to say, three washers of a different make, or two or three ranges?

Mr. Hague:

Well, the only way I could reply to that is, as far as possible, I would, if I were manager of a utility store and as far as my commission would allow me, I would operate that store as if it were my own personal business, and I think that, in most cases, you would find it more profitable to pick out a good line of range or washer, or various other lines, and push one rather than try and push the whole lot. Now that would be my thought. In a great many cases, it would not be possible to do that, because you might be accused of favouring one person, and there might be some discussion about it.

Mr. J. E. B. Phelps, Sarnia:

Mr. Chairman, I think the question asked by Mr. Scott is a very good one. There was a time, in this Province, when Hydro stores were practically sold to various manufacturers, and when a woman came into our stores to buy a washing machine, for instance, and she was shown half a dozen different makes, it all came back to the question of which one was best and "Which do you recommend?" and it was pretty difficult to be loyal to a manufacturer if you were asked to pick any one out and had to say, "That is my pick". Then Mr. Hague this morning mentioned about running our stores along business lines. Now any business man is going to select a certain article and put all his efforts on that article to sell it. If you are going to run a business you have to have a turn-

over. You can't get turn-over with a whole lot of your capital tied up. We pick out a certain line of washer, a certain line of range; we cut our capital investment in stock. We just divide it by three, and we increase our turn.over from two to seven times, and incidentally we make more sales because we confine all our effort to one line and we are giving better service to our people.

Mr. H. F. Shearer, Welland:

Mr. Chairman, I think the question Mr. Scott has raised is one of very great importance. I don't altogether agree with Mr. Hague's interpretation of the question or his answer to Mr. Scott, in that there are different devices or different principles involved in similar types of machine. I mean you have the vacuum cup washer, and you have the gyrator washer. I had rather an amusing experience in our booth at the Welland Fair last Fall. Two ladies were going past the booth, and I overheard one make the remark to the other, "You couldn't get one of those machines in my house on a bet." I broke into the conversation, and asked her what she meant. Some other person in some other Province had told this lady of an experience with that machine, and she was prejudiced against that type, because she had never used it. She had been told that it was no good. I attempted to give her a demonstration of the machine, but saw I was getting nowhere with it, and I finally asked her what type of machine she was thinking of. She told me she preferred a different type; and the result was we were successful in selling a different type of machine which we carried on our floor. In view of that, I think we ought to give consideration to the number of machines we stock, with the thought in mind that the different principles involved will appeal to different people.

The Distribution of Expenses in the Case of Joint Operation of Utilities

By P. B. Yates, Manager, Public Utilities Commission, St. Catharines

(Introduction of discussion at Accounting and Admistration Session of Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 9, 1830.)

WHEN I received the circular letter of the Papers Committee asking if I had any suggestions for an accounting and administrating session to be held during the Convention it occurred to me that it would be an excellent opportunity to get some discussion on a pet theory of mine.

The cost of power to the municipality is out of the hands of the manager and superintendent of the municipality. We not only have no chance to vary our own cost of power, we must accept gracefully any increase in cost which may be wished upon us; in fact we do not often question the cost of power as it is billed to us; the co-operation of the municipalities is based on confidence and we all feel sure that the H.E.P.C. is giving each one of us a fair deal.

But there is one way in which we can modify our over-all cost of power, that is the cost from the Commission to the municipality plus the local cost of distribution. Some of us do a great amount of grouching if power is increased 25c. per horse-power per year, but some of us do not hesitate to add capital cost which may add many 25c. pieces to the cost of power. We all know this and should thoroughly appreciate it and some of us are trying to keep our over-all cost to a minimum.

But there is still another way which to my mind could be used for greater economies and greater reductions in our over-all power costs—that is by combining the local Hydro Commission with other local commission or commissions. In St. Catharines we have a Water Commission made up of a number of men whose term of service on the Commission is from twenty-five to thirty-five years, and they have made a first-class job of their municipal duties. We also have a Hydro Commission composed of members which have been on the Commission for ten years or more and they also feel that they have done a good job. But neither department is being operated to its maximum efficiency and economy until the two departments are combined, and in this way secure a reduction of general expense.

I believe all of you can see economies which will be possible by a combination of the two commissions, and of course some of you have such combination commissions for the operation of two or more departments, and it should not be hard for those of you who have combined commissions to estimate some of the advantages of the combination.

The tendency in municipal life appears to be to meet each need for an organization by the creation of a

new department, and a commission for the operation of the department. This reduces the responsibility of the supreme party, the council of the city, minimizing the value of the council and their authority, and as a result the weight of the council is not going to improve. This same effect will be felt in our commission unless we increase the duties of the Commissions. I have good authority for this idea because the whole thing is cribbed from Dr. Britton of the Municipal Research Bureau.

If by a combination of the Water and the Hydro Commissions in the city of St. Catharines I may be able to save to the power consumers costs equivalent to $1.00 or $2.00 per horsepower per year and similar savings to the water users, I would be very proud of having effected the economy, and I would ask the Convention to give this a moment or two thought and decide whether or not it would be worth while to investigate such methods of reducing power cost. Would the Convention think it wise to appoint a committee, now that the Insurance committee has finished their work, say a committee composed of three of four managers and three or four accountants to report on the possibilities of the suggestion ?

I respectfully solicit your thought and possible discussion to this.

* * * *

Before introducing his paper Mr. Yates craved the indulgence of the meeting in digressing from the original subject. In the discussion both phases of Mr. Yates' paper were taken up, i.e., on one hand the percentage of expenses allocated to the different Departments operating under one Utility and by the same staff, and on the other hand the economic advantage to the citizens and consumers where more than one utility is operated by one Commission.

Common Sense and Electricity

COMMON sense is all that anyone need use in order to keep electricity—the safest, most faithful and dependable of helpers—in its place.

This little bulletin on the subject of using common sense in connection with electricity is something we can all read with profit. All of us use electrical appliances, and much of the work in a beauty salon necessitates the use of electrical appliances. The pointers given in this bulletin are simple, practical and well worth heeding.

1. If protective covering has failed because of wear and tear, because of defect, or has temporarily become ineffective due to water-soaking, a dangerous shock may be received by a person with hands wet or damp who touches a metal socket, electrical appliance or anything connected with electricity while—

Standing on a wet floor,

Taking a bath,

Touching radiators, piping or other plumbing.

2. Secure use of molded composition or porcelain sockets in bathrooms, basements and all other damp locations. Use wall switches where possible. Approved sockets of molded composition or metal sheath porcelain are recommended for use with extension cords.

3. Never leave electric irons on anything that will burn. Always use the metal stand or rest that is provided. Do not use lamps, irons or toasters to warm beds in the winter. Fires may be started by such misapplication of these devices.

4. Extension cords for connecting electrical household appliances or lamps should be handled carefully so as not to injure the protective covering of wires. Have cords repaired or replaced when they become worn. You cannot depend upon defective cords. Long extension cords are unsightly as well as unsafe.

5. Do not use your electrical equipment for playful experimenting or practical joking.

6. Additional wiring in your house should be installed only by a responsible electrician. Your best insurance against fire and accidents is good wiring.

7. If a fuse, the electrical safety valve, blows out, you are over-loading your wiring system or using a defective appliance. The trouble is not corrected by inserting a larger fuse. A fuse of the proper size is your protection against fires or accidents. Ascertain and correct the trouble before putting in a new fuse.

8. Convenience outlets should be installed for connecting portable appliances. Screw base receptacles or outlets are no longer approved. Where they exist, equip them permanently with detachable screw base section of attachment plug or have your electrician replace them. This will prevent inquisitive children from making accidental contact with current-carrying parts.

9. Place outdoor aerials to one side and not crossing over or under power supply wires. A radio aerial which has fallen against power wires is probably alive, regardless of weatherproof covering on power wires. Disconnect power supply from your radio before you do any work on your set.

10. Fallen wires on streets or highways may be alive. Avoid them. Notify the Electric Light and Power Company.

Prepared by Accident Prevention Committee, N.E.L.A.

G. F. Drewry Joins Hotpoint Hole-in-one Club

This is not really news but in case some may have doubts we are going to state the facts. The writer did not see the play but he did see the score card and assuming it to be correct, being verified by three witnesses, it is no bedtime story.

In the May number of *The Bulletin* we passed on the announcement made by the Canadian General Electric Company, Limited, concerning the Hotpoint Hole-in-One Club. One member of the Commission's staff, who took golf more seriously than stray items in *The Bulletin*, immediately commenced intensive training with the result that on July 1st his efforts were rewarded after the

manner of the following lines copied from "*Abitibi*" and vouched for by the three witnesses.

THE MYSTERY WORD

I shot a golf ball into the air,
It fell to earth, I knew not where.
I sought it vainly and in the end
I uttered a word which I don't defend.

At last that ball which was lost to me
I found in the hole where it ought to be,
And then that word which I don't defend
I heard again from the lips of a friend.

At least Fred said, "Hot Dawg", and Don remarked that, if he "fell into a glue pot he would come up smelling like a rose".

While playing a round with H. C. Don Carlos, J. N. Wilson, (both of this Commission) and Allen Don Carlos, G. F. Drewry dropped his tee shot on the 170-yard fifteenth into the cup. The newspapers told all about the play on the following morning so that later in the day Fred received a second surprise when he was advised that he had qualified as a member of the Hotpoint Hole-in-One Club which he did not know existed, and also that he was the initial member of that organization.

All of this taking place just one week prior to the Convention at Bigwin Inn, the presentation of the Club Certificate, and the prize he selected, a Hotpoint Waffle Iron, was made during one of the Convention luncheons. The presentation was made in fitting style by Mr. M. J. McHenry, Manager of Canadian General Electric Toronto District Office, and Fred was made the recipient of hearty congratulations. It

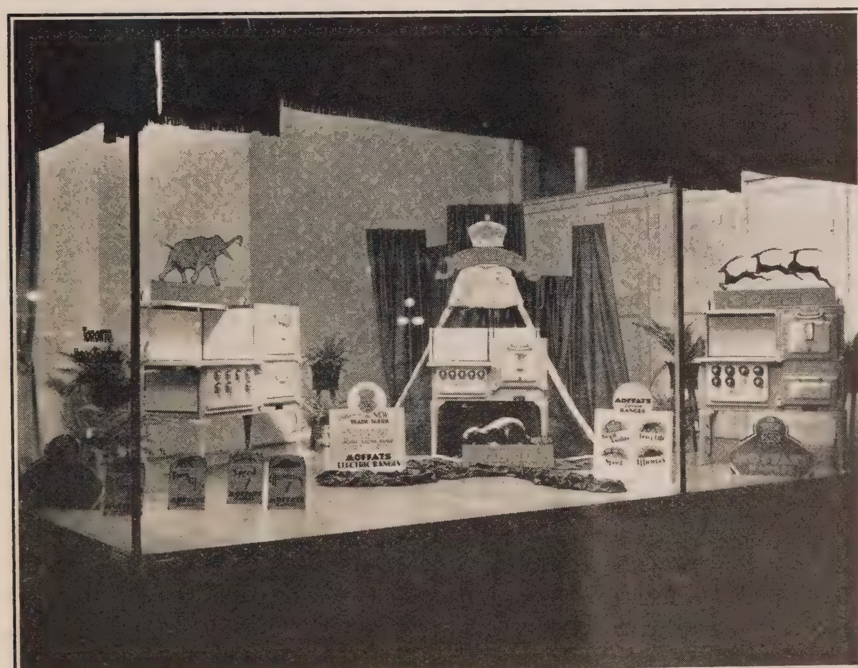
Hotpoint Hole-in-one Club Certificate presented to G. F. Drewry

is a rare distinction to be the first and only member of any club. We understand that one other has since qualified for membership so from now on Fred should not feel lonesome.

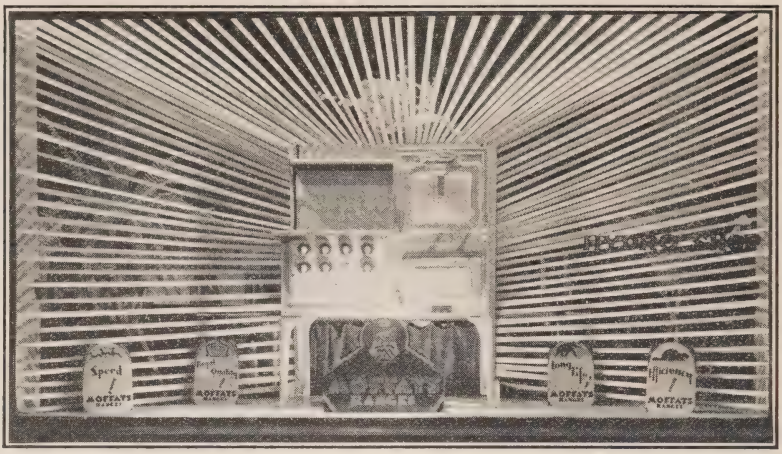
Hydro Shops Win in Window Display Contest

The two accompanying illustrations are of window displays that were awarded first prizes in a Dominion-wide contest this year. The manufacturer of the electric ranges shown held a contest extending over the whole of the Dominion of Canada, early in the year, offering prizes for the best window displays of their goods. Displays entered in the competition were placed in one of two general classifications. These were judged by three independent judges who made their selections on originality, effectiveness, and selling punch, regardless of the size of the dealers' windows. The display of The Toronto Hydro Shop was awarded first prize in its class because of the outstanding simplicity of the window and the way in which the various qualities of the ranges were exhibited. The Hydro Shop of Chatham, Ontario, was awarded first prize in its class. This was on account of the radiation of decorative material and the illumination of the range giving an effect of outstanding simplicity and brilliance.

The winning of these two prizes speaks well for the ability of Hydro Shop display men—more power to them.



Hydro Shop, Toronto



Hydro Shop, Chatham, Ont.

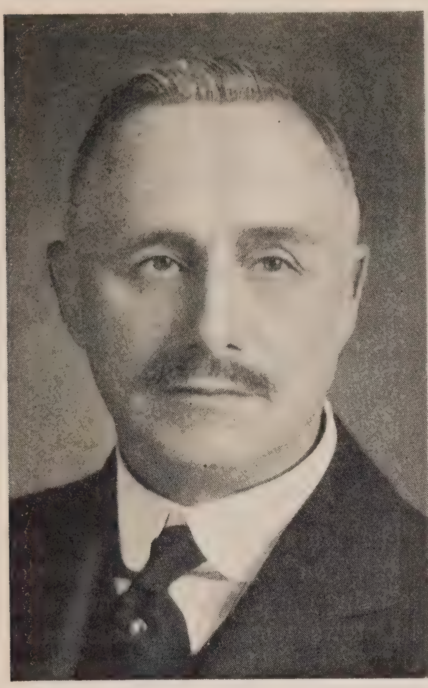
P. E. Hart, Toronto

By the death of Percival Edward Hart, Chief Engineer, Toronto Hydro-Electric System, on September 9th, 1930, we mourn the passing of another who has played an important part in the building up of Hydro.

Mr. Hart had been quite ill since the first week in July, though his condition was not considered serious at the time. During the last week of his illness, he showed considerable improvement and, while it was not expected that he would come back to normal health for some time, his death came as a distinct shock to his many friends. The funeral on Friday, September 12th was largely attended and bore fitting testimony to the high esteem in which he was held generally by both fellow employees and a host of other friends.

Mr. Hart was born at Turnchapel, near Plymouth, England, January 9, 1870. He received his early education in the School of Science, Cardiff, Wales. In 1888 he came to Canada and settled at Brandon, Man.

He first started on his electrical career in 1889, when he took charge of the plant of the Brandon Electric Light Co., Brandon, Man. In 1891 he left the Brandon Electric Co. to take a position with The Edison General Electric Co., which later became the Canadian General Electric Co., and held the position of Superintendent of Construction for the Maritime Provinces for this company from 1893 to 1895 with headquarters in Halifax. In 1895 he was appointed special expert on heavy installations for the same company, and in 1901 he was transferred to the Head Office where he was in charge of contracts and later Chief Estimating Engineer in the Contract and Sales Department. In 1913 he left the Canadian General Electric Co. and joined the staff of the Toronto Hydro-Electric System as Electrical Engineer. He was later appointed Managing Engineer and finally Chief Engineer, the position he occupied at the time of his death.



Percival Edward Hart

Mr. Hart was of a quiet and reserved disposition. His hobby was the reading of good books and on this account he was particularly well informed on a great many subjects. He was a Fellow of the American Institute of Electrical Engineers, a Member of the Engineering Institute of Canada and a registered professional engineer of Ontario. He was also a member of the Engineers Club of Toronto.

He was a man of considerable foresight and it was for this reason that when large blocks of power were demanded by the rapidly growing industries of Toronto, the Toronto Hydro-Electric System was always ready to serve. He also believed in the old adage that if a thing was worth doing at all, it was worth doing well. The work of the Engineering Department as represented by Toronto's great electric system is a tribute to the ability of an engineer who has so concientiously and energetically carried on the work entrusted to him.

Mr. Hart had a large circle of friends and to those who knew him personally his death is indeed a great loss. He is survived by his widow, one son Erwin and a sister, to all of whom are extended heartfelt sympathy.

Hydro News Items

Eastern System

A temporary power load of 75 h.p. has been obtained in Lancaster for the operation of a road making plant.

* * * *

A rural extension has been completed from Crysler to St. Albert and an extension is under way from Winchester to Winchester Springs in the Chesterville Rural Power District.

* * * *

Approximately 42 miles of rural lines are to be added this year to the present lines in the Townships of Ameliasburg, Hillier and Halliwell in the Wellington Rural Power District.

* * * *

Lines are being constructed from Sydenham to Harrowsmith and also from Odessa to Wilton, in the Kingston Rural Power District. The lines in Odessa and Sydenham have been made alive this summer. Extensions in this district have amounted to 45 miles within the past year and it has been necessary to install a rural transformer station at Cataraqui and change the lines to operating at 8,000 volts.

* * * *

The transmission system of the Beach Rural Electric System, Limited, has been purchased by the Commission. This system consists of 80 miles of 3 phase and single phase transmission lines north of the Village of Iroquois in the Townships of Matilda, Mountain, South Gower, Williamsburg and Winchester. There are 390 consumers served from the system. Electric power for the system is obtained from the generating station of the Estate of M. F. Beach at Iroquois.

* * * *

Niagara System

The Harriston, Palmerston, Milverton and Listowel rural districts are being operated from a new office at Listowel where C. R. Cole, late of St. Marys, has been appointed superintendent.

* * * *

A new transformer bank of 7,500 kv-a. capacity has been installed at Guelph H. T. station together with new 13,200 volt outdoor switching equipment. These will be ready for service about October 12th.

* * * *

The capacity of Hespeler Municipal station has been increased from approximately 900 kw. to 1,500 kw. by the installation of a three-phase, outdoor-type, self-cooled transformer.

* * * *

A 23-mile rural extension between Palmerston and Drayton and constructed via Teviotdale and Rothsay, in Palmerston Rural Power District, has recently been made alive and placed in operation.

* * * *

A new rural office is being opened at Clinton to handle the operation of

the Goderich, Walton and Clinton rural districts. A. M. Knight, formerly on the staff of the Mitchell R.P.D., has been appointed superintendent.

* * * *

The Kitchener Public Utitilities Commission are erecting a reinforced concrete storehouse to cost $38,000.00 The building will be 60 ft. by 80 ft., having two floors and a 9 ft. 6 in. basement, and equipped with elevator and loading platform.

* * * *

The double circuit 13,200-volt feeder from Kitchener H.T. station to Waterloo formerly carried over one route, has been separated and is now carried on individual pole lines giving increased conductor capacity and greater assurance of continuity of service.

A Correction

The Editor

Hydro Bulletin

In the discussion of our paper "Paints and Painting", which was published in the July issue of the Bulletin, I would like to correct one or two statements, as follows:—

1. On page 278, where it states "Mr. Acres has taken" it should read "Mr. Craig has taken."

2. On page 279, the answer to the question "Might I ask if you have had any experience with paints, using as a base what is called china wood oil?" is somewhat misleading, and the points I wished to bring out are as follows :—

"China wood oil has a tendency to check when exposed to direct sunlight. This feature may be reduced by blending with linseed oil. Ninety per cent. of the paints made with china wood oil vehicles, which we have given exposure tests, have failed by checking. China wood oil is generally cooked with some gum or resin, usually common resin. As a rule, such paints have a high gloss and self-levelling properties which resemble enamel finishes. These finishes are excellent for interior exposure, but our experience has been that they are very much inferior to linseed oil on outside exposures."

Yours truly,

T. H. Chisholm,
Chemist
H.E.P.C. of Ont.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Elliott Chute Development

By J. J. Trail, Asst. Engineer, Hydraulic Dept. and N. F. Seymour, Asst. Engineer, Electrical Engineering Dept., H.E.P.C. of Ont.

THE Elliott Chute development, which came into service in October, 1929, is the third of the Commission's plants on the South River and the third also serving the Nipissing System. This system, comprising the city of North Bay and the villages of Callander and Powassan, along with a number of rural customers, is not interconnected with any of the Commission's other systems, and is therefore dependent for power on the three plants named.

Due to some of the characteristics of the river, it was becoming increasingly difficult to meet the growing load demands of the system, and the construction of the plant, along with the storage basin in connection therewith, became necessary. In fact, it was so greatly needed that it was brought into service some weeks earlier than was at first planned and before construction was fully completed.

The South River rises in the westerly part of Algonquin Park, and flows in a north-westerly direction to Lake Nipissing. There are a number of small lakes in the catchment area, but these are generally at, or near, the sources of the various tributaries of the main stream. A number of these have been developed as storage basins but the efficiency with which the storage could be used in the winter months was greatly impaired by the freezing of a considerable quantity of the stored water on its long course from storage basin to power house. Development of additional and more efficient storage was essential for satisfactory operation of the existing plants at Bingham Chute and Nipissing. Additional generating capacity was also necessary.

The storage basin above the dam at Elliott Chute is thus an important part of the development. It is advantageously located with respect to the other plants, as the discharge

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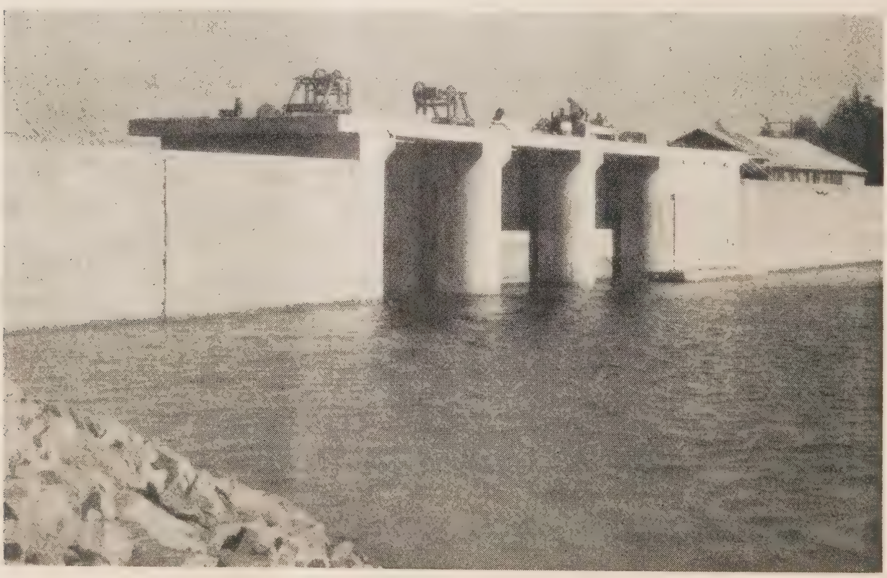
from the Elliott Chute plant passes at once into the headpond at Bingham Chute, and only a few miles of river channel separate the tailwater of the latter plant from the Nipissing headpond. The stored water will thus be used efficiently, as there will be little opportunity for the loss of water in passage from plant to plant, as was the case with the storage basins near the headwaters of the river.

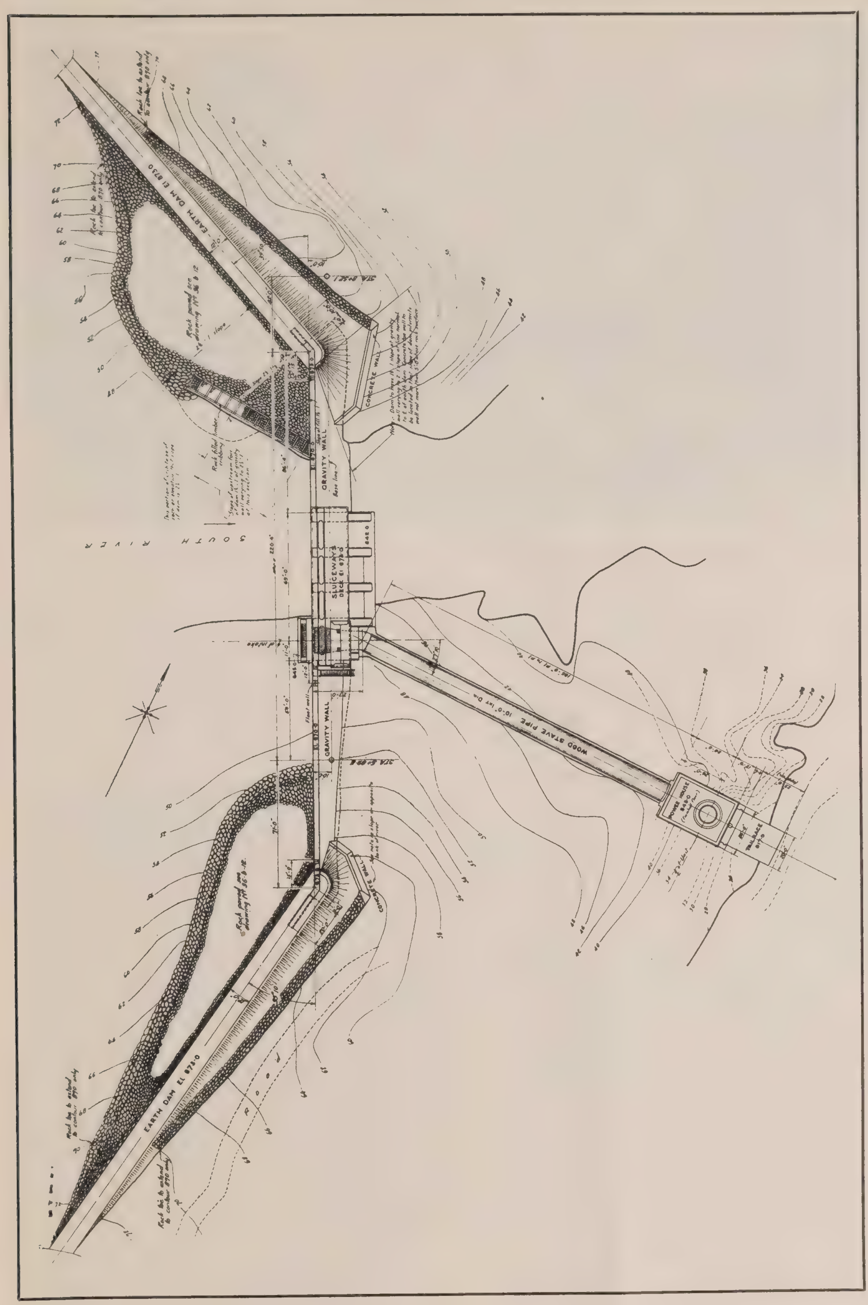
The storage basin has an area of 730 acres at elevation 868.5, and a capacity of 6,200 acre feet between elevations 855 and 868.5. The drainage area upstream from it is 234 square miles and, with this storage, is expected to assure a continuous flow sufficient for operation of all plants at capacity, when allowance is made for system load factor.

The dam consists of a south earth fill, a central concrete section including headworks and spillway, and a north earth fill.

The south earth fill is 240 feet in length, has a top width of 12 feet, top elevation 873, upstream slope $2\frac{1}{2}$:1, and downstream 2:1. The upstream



Main dam from upstream side, water surface about six feet below normal level



Plan of the Elliott Chute Development.

face is protected from wave action by rock paving one to two feet thick, and a rock toe is provided at the extremity of the downstream slope to support the slope and ensure drainage of the fill. Water-tightness was secured by the use of an impervious core of clay, with a small percentage

New township road built to replace road closed by storage reservoir.

of sand, forming the middle third of the fill, carried up to elevation 871, and sealed at the bottom by a cut-off trench, with a width of five feet, carried three to five feet into the material forming the foundation of the dam.

The north earth fill is 210 feet long, and is similar in most respects to the south earth fill. A rock-filled timber crib gives protection from scour to the portion of the upstream slope close to the sluiceway.

6,600 cubic yards of earth fill, and 1,500 cubic yards of rip-rap were required for the two earth fill dams.

The concrete section of the dam, about 300 feet in length, unites the ends of the two earth fills, and includes in its length, starting from the south end, a gravity section 125 feet long, an intake section 22 feet long, a sluiceway section 58 feet long, and a second gravity section extending into the north earth fill. A concrete core wall, two feet thick, carried to rock surface with top at elevation 870, extends from the south end of the gravity section for 20 feet into the south earth fill, and at the north end for 10 feet into the north earth fill.

Three sluiceways, forming the sluiceway section, each having a clear width of 14 feet with sills at 842 to 844, have a discharge capacity in excess of any flood that is expected to occur.

South of, and adjacent to the sluiceways, is the intake structure. The entrance to this is through an opening 18 feet wide and 13 feet high, protected by racks which will be exposed only when the water in the reservoir is close to the minimum operating level. A single sliding gate closes the entrance to the penstock, and stop-log checks are provided above the gate. A wood-stave penstock, 10 feet in diameter and 185 feet long, leads from the intake to the power house, and discharges into a pressure flume of concrete.

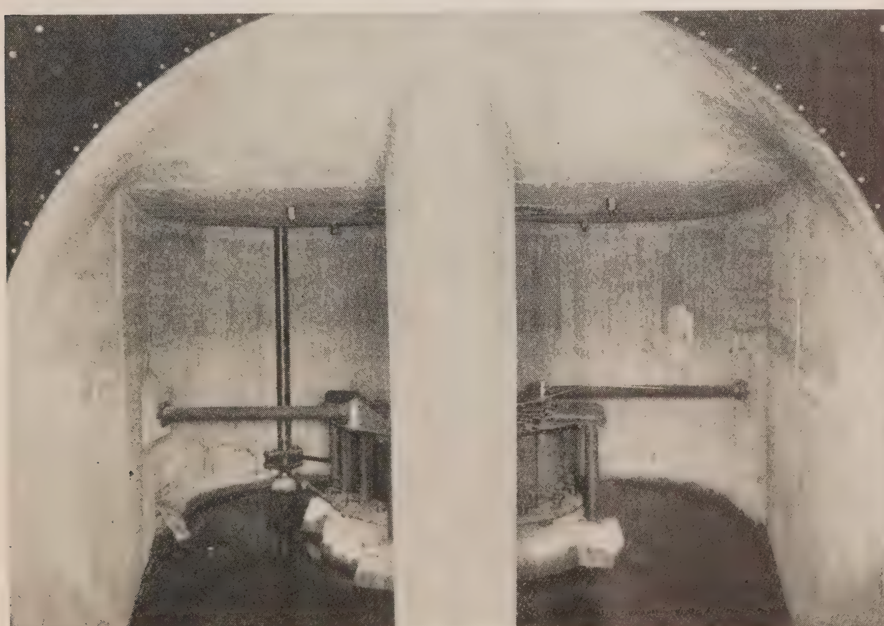
The turbine unit, built by the S. Morgan Smith-Inglis Company, of

Toronto, has a single vertical runner of the propeller type, rated at 1,800 horsepower at 327 rev. per min. under a head of 39 feet. The specific speed of the wheel is 143, and a maximum efficiency of 89 per cent. is guaranteed. Regulation is effected by means of a Woodward self-contained governor, having a capacity of 16,300 foot-pounds. The draft tube is of plate steel with vertical axis, is conical in its upper portion, and somewhat bell shaped at its outlet.

The discharge from the plant returns directly to the South River, about a quarter of a mile upstream from the slack-water of the Bingham Chute headpond, and a few miles below Bingham Chute the headwaters of the Nipissing plant are reached. The proximity of the plants to each other makes stored water in the Elliott Chute reservoir immediately available to meet the load demands of the system.

The construction of the reservoir involved a considerable amount of road relocation and construction. This required the placing of over 14,000 cubic yards of earth fill, and about 2,500 cubic yards of gravel in the relocated and raised roads, over twice as much as was required for the earth fill portions of the dam. 3,300 feet of guard fencing also were required. It was necessary to reconstruct and raise, by 10 feet, the bridge on the township line between Nipissing and Himsworth townships.

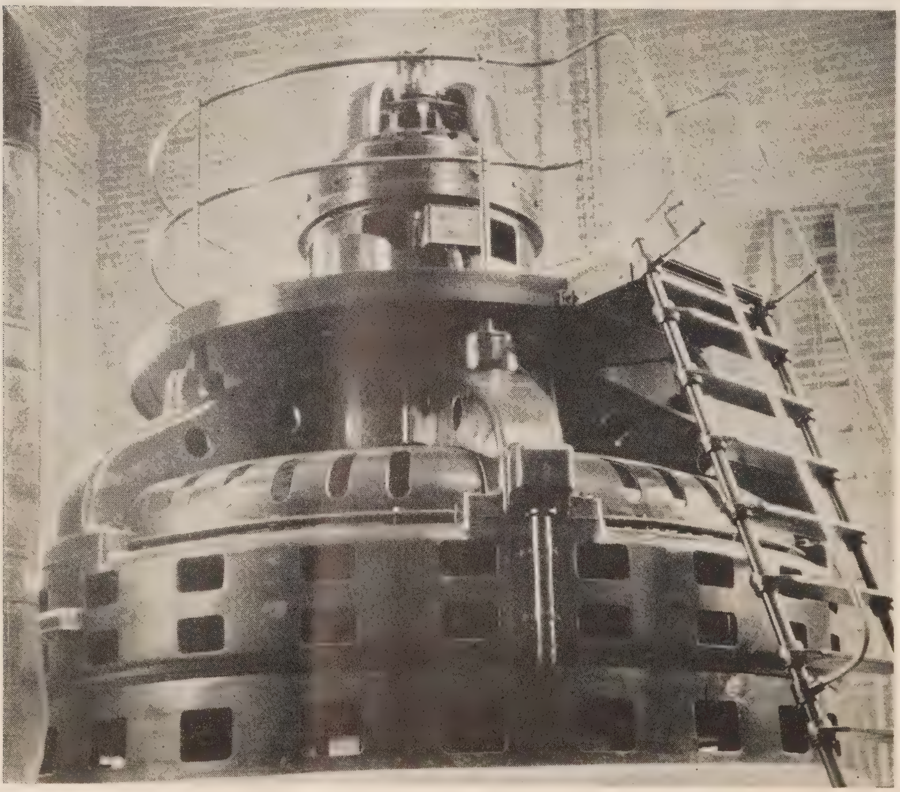
The superstructure of the plant is designed to house one generator with its switching and automatic equipment, and is 36 feet by 26 feet by 31 feet high, constructed of dark red pressed brick outside and buff pressed brick inside. A roof monitor, 7 feet



Interior of pressure flume from penstock, showing turbine.

by 4 feet 6 inches, and three wall louvres installed in the walls just above the floor are provided to supply the proper ventilation of the power house and generator. A 12½ ton, hand-operated, chain block is installed in the building for erecting and dismantling the generator. A battery room, 7 feet by 4 feet 6 inches by 9 feet high, is built in the one corner of the building to house the 110 volt battery required for the operation of this plant.

The generator in this plant is a Swedish General Electric Company vertical type machine with a spring type thrust bearing to carry the weight of the rotor and the turbine runner. The rated capacity of the unit is 1,800 kv-a., 80 per cent. power factor, 3 phase, 60 cycle, 2,300 volt, 327 revolutions per minute with direct connected 22 kw., 125 volt exciter. The machine is lubricated by a self contained system, the oil being circulated by a pump geared off the generator shaft, from the reservoir of the lower guide bearing to the thrust bearing chamber and from there by gravity to all other bearings. The oil is kept cool by passing it through a water cooled oil cooler located under the generator. Space is provided for this oil cooler in this location by the required height of the generator concrete base ring



1,800 kv-a., 3 phase, 2,300 volt Generator, in Elliott Chute power house.

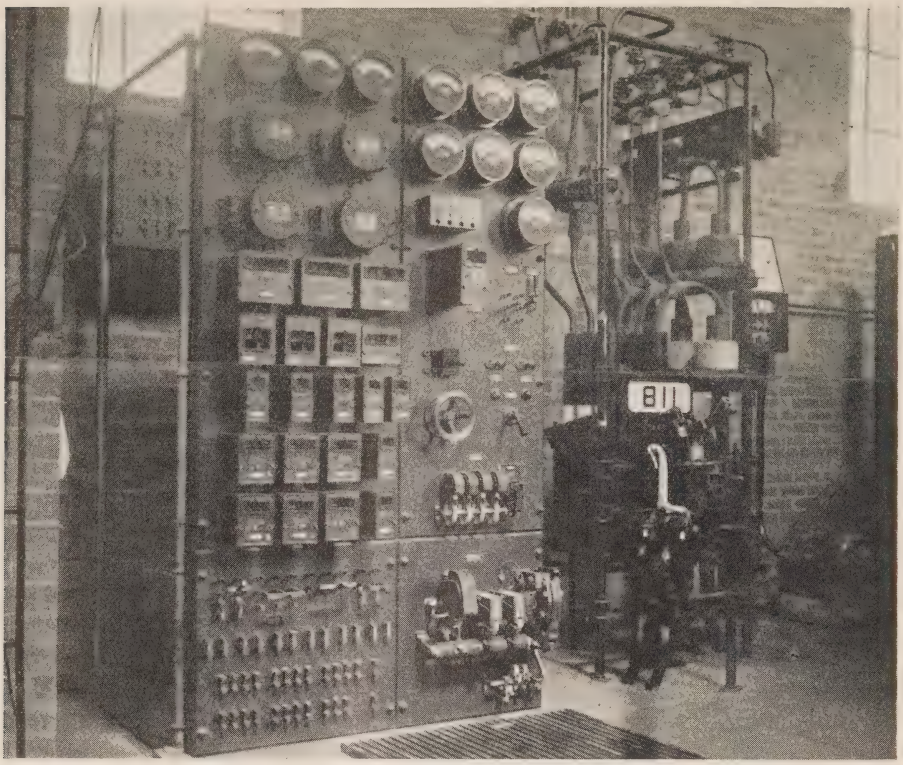
Interior view of Elliott Chute power-house showing generator switch, turbine governor and generator base ring permitting placing the oil cooler equipment under the generator.

which extends 3 feet 7½ inches above the finished generator room floor. The water for this cooler, as well as the main station supply, is taken from the turbine chamber and discharged into the tail race chamber through pipes.

This unit is designed for self synchronizing, being provided with a 95 per cent. speed contact which automatically closes the generator oil circuit breaker and places the unit on the line when the master starting element has been closed and the automatic starting sequence has reached the proper stage. This unit may also be manually operated or automatically started and manually synchronized with the system by remote control.

The power developed by this unit at 2,300 volts is stepped up to system transmission voltage (22,000 volts) by means of three English Electric Company 650 kv-a., single phase, 60 cycle, outdoor type transformers. These transformers are installed outdoors with a steel pipe structure for their switching equipment and are tied to the system through a remote controlled 22 kv. oil circuit breaker.

A bank of two 5 kv-a., and one 15 kv-a. service transformers is installed in the station to step the voltage down from 2,300 volts to 110–220 volts for the supply of all motors used in conjunction with the automatic features as well as control, lighting, heating and cottage service at the plant. The supply for this service



Automatic operating devices, relay and metering equipment and generator switch.

bank is tapped from the 2,300 volt bus on the transformer side of the generator breaker and protected by means of expulsion type fuses.

A 60-cell storage battery and a trickle charger is installed in this station for the supply of all direct current control service required for the automatic and remote control of the plant.

The automatic control of the unit in Elliott Chute is installed in the Bingham Chute Generating Station as well as the remote control manual synchronizing equipment. In emergency conditions, the unit in Elliott Chute can be manually operated. All control and indicating wiring between these plants consists of a 40 conductor lead covered cable carried mainly on a separate pole line from that used for the power transmission line. This cable is approximately $1\frac{1}{3}$ miles in length and is carried into both stations through a set of telephone protective devices consisting of 14 ampere fuses and carbon blocks for grounding excessive voltages which might be induced in this cable due to short circuits on the power transmission lines.

Load and voltage indications are recorded in both stations for manual or automatic control. In Elliott Chute there is installed an indicating wattmeter, watthour meter, voltmeter and ammeters while in Bingham Chute there is installed a volt-

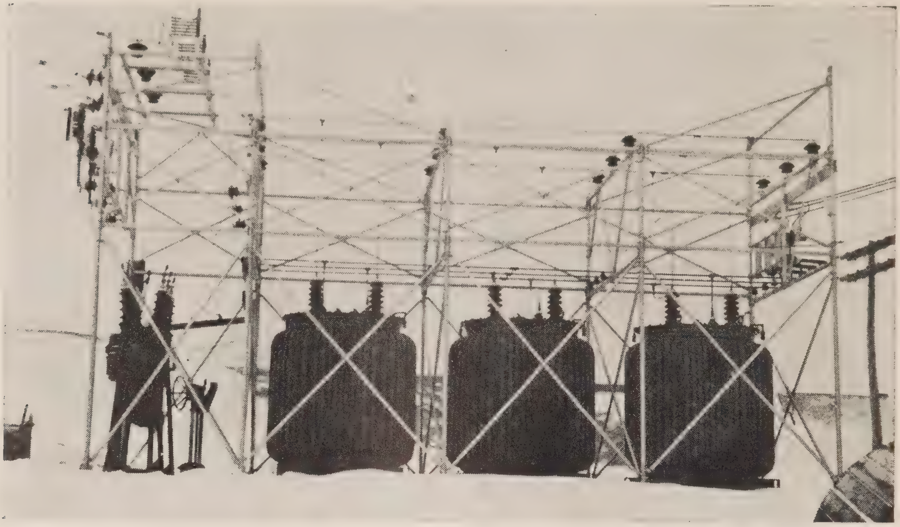
meter and two recording potentiometers actuated by means of four polyphase thermal converter transmitters installed in the Elliott Chute Plant. Also manual synchronizing equipment has been installed in both stations whereby the unit may be manually or automatically started and manually synchronized on the system. Once the unit has been placed on the line by the operators in Bingham Chute, either automatically or by manual synchronizing, they have control of this unit by means of push pull button switches to vary the speed and voltage of the unit. Consequently, with water level indications in Bingham Chute, the operators here are able to manipulate load conditions on the two plants to pass sufficient water for the system load without wastage.

In starting up the machine under self synchronizing conditions from Bingham Chute, the operator must know that the automatic equipment in Elliott Chute has been left for this arrangement with number 44x auxiliary switch closed. He then closes the 22 kv. line breaker by means of the control switch in Bingham Chute with indicating lamps to show the position of this breaker, making the Elliott Chute station service transformers alive and ready for service. The operator has then only to pull a pull button switch in Bingham Chute which closes the master element and the unit is automatically started up, thrown on the line and brought up to voltage and the operator can then load the machine as desired by means of his speed and voltage control pull button switches.

In starting up the machine under manual synchronizing conditions from Bingham Chute, the operator must know that the automatic equipment in Elliott Chute has been left for this arrangement with number 44x auxiliary switch open. He then proceeds as for automatic synchronizing starting the unit and, when started, he has control of the speed and voltage by means of the push pull button switches and when the proper synchronizing conditions are indicated on the synchronizing instruments, he closes the Elliott Chute generator breaker by means of the control switch in Bingham Chute.

The unit may be started similarly in Elliott Chute in case of trouble in the control cable or may be started manually.

In shutting down the plant the operator reduces the load by means of the control buttons, and then he can either shut down the unit and leave the station service alive, or he can shut down the whole plant. The whole plant is shut down by putting the 22 kv. breaker control handle in the trip position tripping the 22 kv. breaker and generator breaker at Elliott Chute and the master element in Bingham Chute. The unit is shut down leaving the station service alive by putting the generator breaker control handle in the trip position tripping the generator breaker in Elliott Chute and the master element in Bingham Chute. In operating the unit from Elliott Chute, the plant can be taken off the line and left running to supply the station service. When the plant is shut down by any of the above methods or by the automatic relays, the automatic sequence on the governor and control



Out-door 22 kv., switching equipment and step-up transformers.

devices at Elliott Chute shuts down the unit and applies the brakes. These brakes are of the oil pressure type and although automatically applied by the governor, are arranged for hand pumping.

In case of trouble the unit is promptly cleared from the system by relays provided for this purpose and the plant shut down automatically. In addition to the protective devices normally supplied on manually operated plants, this unit has the following which are in two classes,—

(a) Relays which clear the unit from the system and shut the plant down which will allow the immediate restarting of the unit without inspection if desired as follows,—

1. Alternating current overvoltage relay which shuts down at 21.7 per cent. overvoltage.
2. Direct current overvoltage relay which shuts down at 12 per cent. overvoltage.
3. Low governor oil pressure relay which shuts down when the pressure drops to 140 pounds. Normal pressure 160 to 200 pounds.

(b) Lock out relay which clears the unit from the system and locks out the plant when the trouble must be remedied and this lock out relay hand reset before the unit can be started up again. This relay is operated from,—

1. Overspeed mechanical device on the generator which operates at 18 per cent. overspeed (385 revolutions per minute).
2. Thermostats of the dial type on all bearings which operate in case of excessive heating of any bearing.
3. Direct current undervoltage relay which closes its contacts if the exciter voltage drops to 28 volts.

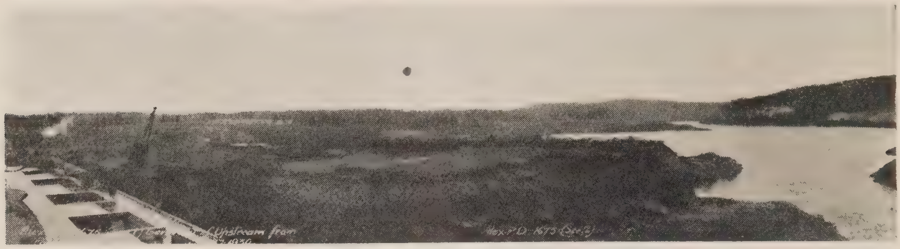
4. Differential relays which operate through an auxiliary relay to operate the lockout relay consisting of,—
   (I) Generator differential which operates on generator differential.
   (II) Zone differential which operates in case of a short circuit anywhere in the Elliott Chute station equipment.
   (III) Short Distance differential which operates in case of short circuit in the power transformers or on the 22kv. line.
   (IV) Long distance differential which operates in case of short circuit in the power transformers 22 kv. line or transformers at Bingham Chute, Nipissing and North Bay.

In addition to the above relay protective devices for shutting down the plant, there is installed in Bingham Chute Station a number of indicating lamps which indicate conditions in Elliott Chute as follows,—

1. When there is a ground on the system.
2. When the lock out relay has operated locking out the plant.
3. When the operator closes the exciter rheostat switch for raising or lowering the voltage which indicates until the rheostat arm has reached its extreme raise or lower position.
4. When the governor speed indicator is in the proper position for automatic starting.
5. When the 22 kv. breaker is open or closed.
6. When the generator breaker is open or closed.

The complete switching and control apparatus was arranged by the Commission's Engineers. Standard contactor switches and relays and special relays were purchased from the different manufacturers and connected in to meet the desired operation and protection of this plant.

This station was placed in active service under the semi-automatic control in March of this year, all construction being carried out by the Construction Department of the Commission.



During construction of the Alexander development on the Nipigon River, the flow passed through a diversion canal and temporary sluices in the dam. These sluices were closed on September 30th, and the headwater brought to the operating level. The upper picture, taken from the Generating Station roof on September

Use of Electrical Appliances by Domestic Consumers in the Province of Ontario

By G. J. Mickler, B.A.Sc.. Sales Dept., H.E.P.C. of Ont.

IT is a well known fact that the people of Ontario, particularly the Domestic consumers, served by Hydro Municipalities, are well supplied with electrical appliances both large and small to enable them to take advantage of the abundant supply of electricity which is available for their use and to take advantage of the extremely low rates of service which prevail in these municipalities. Statistics show that there is an ever increasing number of kilowatt hours used by the average consumer from year to year and also that there is a constant lowering of the average cost per kilowatt hour. Neither of these items have reached their limit; in fact, there is practically no limit to the number of kilowatt hours that can be consumed by use of power in the home on account of the many new appliances which are finding their way into the household, appliances which were undreamed of a decade ago.

In order to form a picture of what has been going on in recent years surveys have been made by Hydro municipalities to ascertain the number of Domestic electrical appliances in use from year to year, and for the past six years figures have been tabulated which show a healthy

27th, shows the river before the water was raised; and the lower picture, taken two days later, shows the headwater at operating level, the river replaced by a large headpond, and the whole flow of the river passing over the spillwall to the right.

growth in practically every line of appliances.

Every year since 1925 figures have been presented through this Bulletin showing the results of these surveys and the accompanying tabulation shows the present estimated condition of affairs with figures for three or four other years for comparative purposes.

It is interesting to note the steady increase in the saturation point in practically every item of appliance used. For instance, in electric ranges the saturation point rose from 13.8 per cent. in 1924 to 24.4 per cent. in 1929, electric hotplates from 5.5 per cent. to 10.4 per cent., electric washers from 15.8 per cent. to 27.9 per cent., electric cleaners from 18.6 per cent. to 22.1 per cent., electric water heaters from 4.8 per cent. to 8.8 per cent., electric ironers from 0.4 per cent. to 0.9 per cent., electric refrigerators from 0.2 per cent. to 5.9 per cent.

It will be seen that in the larger electrical appliances the use is almost double what it was in the year 1924. Notwithstanding this fact, however, we are a long, long way from reaching the point where everybody is fully equipped with electrical appliances for home use.

It is interesting also to note the increase in estimated installed capacity of these appliances from the year 1924 to the year 1929, the former figure being 1,081,640 h.p. and the latter 1,940,920 h.p. Again the capacity has almost doubled itself in the five year period.

There are many other interesting features in the Table presented herewith of interest to the manufacturers and distributors of these electrical appliances shown to demonstrate the

TABLE No. I.

TABULATION SHOWING THE NUMBER OF THE LARGER ELECTRICAL APPLIANCES REPORTED TO BE IN USE AMONG HYDRO DOMESTIC CONSUMERS IN ONTARIO AT THE END OF 1929 AND THE NUMBER CALCULATED TO BE IN USE DEDUCED FROM FIGURES REPORTED. ALSO THE TOTALS ESTIMATED FOR 1924, 1926 AND 1928 FOR COMPARISON

	Estimated number in use Dec. 31, 1924, by 344,250 consumers.	Percentage Saturation	Estimated installed capacity Kw.	Estimated number in use Dec. 31, 1926, by 376,882 consumers.	Percentage Saturation	Estimated installed capacity Kw.	Number calculated in use Dec. 31, 1928, by 414,139 consumers.	Percentage Saturation	Estimated installed capacity Kw.	No. of Electrical Appliances Estimated to be in use among 431,270 consumers at Dec. 31, 1929.	Percentage Saturation	Estimated installed capacity Kw.
Electric Ranges..........	47,505	13.8	285,030	70,883	18.8	425,298	95,906	23.1	575,436	105,312	24.4	631,872
" Hot Plates........	18,883	5.5	37,766	25,291	6.6	50,582	38,699	9.3	77,398	45,188	10.4	90,376
" Washers..........	55,342	15.8	11,068	78,063	20.7	15,612	107,370	25.9	21,474	120,393	27.9	24,078
" Cleaners..........	64,205	18.6	12,841	75,120	19.9	15,024	90,275	21.8	18,055	95,138	22.1	19,276
" Water Heaters.....	16,605	4.8	25,000	26,069	6.9	39,100	37,028	9.0	55,542	38,136	8.8	57,204
" Grates...........	15,075	4.4	30,150	16,812	4.4	33,624	17,620	4.3	35,240	19,878	4.6	39,756
" Air Heaters.......	103,000	30.0	82,400	106,125	28.0	84,820	149,900	36.2	119,920	155,734	36.4	124,587
" Ironers...........	1,590	0.4	4,770	2,255	0.6	6,765	3,045	0.8	9,135	3,968	0.9	11,904
" Irons.............	307,800	89.2	203,148	311,377	82.9	205,508	370,820	89.9	244,741	381,490	89.9	251,783
" Refrigerators......	657	0.2	130	2,667	0.7	533	16,338	3.9	32,676	25,000	5.9	50,000
" Toasters..........	152,200	44.1	83,710	160,077	42.5	88,042	194,637	47.0	107,050	217,498	50.4	114,123
" Grills.............	46,800	13.8	30,888	42,000	11.2	27,720	45,262	10.9	29,872	49,879	11.6	32,970
			806,901 kw.			992,628 kw.			1,326,739 kw.			1,447,929 kw.
			1,081,640 h.p.			1,330,600 h.p.			1,778,470 h.p.			1,940,920 h.p.

fact that there is still a wide market for their produce.

It may be of interest to readers of this article to know to what extent Hydro Shops have contributed during the past five years through their sales towards improving the use of electrical appliances among their customers. A short table is given below in which the total sales of all Hydro Shops in the Province for the past five years are given, and it might be mentioned in passing that a study of the individual census returns from the various municipalities show that where Hydro Shops exist there are more appliances in use of all kinds than where no Hydro Shops exist, with very few exceptions.

tabulation gives an idea of the extent to which rural customers are making use of the service which has been brought to their doors.

In studying this Table it will occur to the reader that there are many more motors reported in use than there is equipment to be driven by such motors and in this connection it may be well to mention the fact that in submitting census returns many consumers evidently omitted to show what equipment was motor driven. Furthermore, it is possible that many of the pumping systems shown as electrically driven are not self contained.

Taking into account the deficiency as mentioned above, one cannot help

TABLE No. II.

HYDRO SHOP SALES OF APPLIANCES FOR FIVE YEARS 1925 TO 1929 INCLUSIVE

	1925	1926	1927	1928	1929
Ranges	4612	4491	3430	3119	2837
Hot Plates	949	1100	1008	1269	1334
Washers	2268	2192	2064	1869	1981
Vacuum Cleaners	1442	1341	1476	1576	1757
Water Heaters	889	993	932	791	782
Grates	224	191	129	133	119
Air Heaters	1201	1190	851	705	771
Ironers	110	72	95	115	119
Irons	7514	8385	7197	6726	6027
Refrigerators	109	216	253	351	291
Toasters	2412	2488	2584	3182	3144
Grills	953	693	557	425	234

For the past two years an endeavour has been made to ascertain to what extent rural customers are making use of electrical appliances and equipment which can be driven by electric motors, and the following

but gather from these figures that rural consumers are not making the best use of electric service, especially in their barns.

On examination of the figures on household appliances it is interesting

TABLE No. III.

SUMMARY OF EQUIPMENT AND APPLIANCES IN USE BY RURAL CUSTOMERS.

	1929 Total	1929 Saturation %	1930 Total	1930 Saturation %
Actual Number of Farm Customers Submitting Returns	7074		8239	
BARN EQUIPMENT:				
Motor	1877	26.5	2360	28.6
Elec. Pump System	1748	24.6	2079	25.2
" Milk Cooler	22	0.3	12	0.1
" Churn	43	0.6	56	0.7
" Drill	9	0.1	23	0.3
" Water Heater	30	0.4	31	0.4
" Soldering Iron	18	0.2	11	0.1
" Chick Brooder	136	1.7	182	2.2
Milking Machine	283	4.0	329	4.0
Feed Grinder	322	4.5	351	4.3
Cream Separator	397	5.5	520	6.3
Ensilage or Straw Cutter	120	1.7	113	1.4
Hay Hoist	13	0.2	15	0.2
Tool Grinder	200	2.8	257	3.1
Miscellaneous Tools	80	10.4	183	2.2
HOUSEHOLD APPLIANCES.				
Elec. Range	1350	19.1	1661	20.8
" Hot Plate	1155	16.3	1452	17.6
" Washer	3514	49.7	4431	53.7
" Vacuum Cleaner	654	9.2	663	8.1
" Water Heater	222	3.0	231	2.8
" Grate	75	1.0	67	0.8
" Air Heater	688	9.7	713	8.6
" Ironer	34	0.5	50	0.6
" Iron	6283	88.8	7401	89.8
" Refrigerator	194	2.7	254	3.1
" Grill	158	2.2	129	1.6
" Toaster	3607	51.0	4224	51.3
" Churn	74	1.0	61	0.7
" Radio	968	13.7	1829	22.2
" Percolator	143	2.0	145	1.8
" Fan	136	1.9	115	1.4
Sewing Machines	18	0.2	84	1.0

to note the comparison in many cases between the saturation point among rural consumers and that among urban consumers. It is found that practically the same percentage of rural customers operate electric ranges as do those in urban centres, and when we look at the washing machines we find that the use among farmers is almost double that among consumers in Towns and Cities. Of course this may be due to the fact that the facilities of large steam laundries in the urban centres do not extend to the rural districts and that there may not be the same need for electric washers in the Cities and Towns that there is among the farmers. Figures on the other appliances are equally interesting and are worthy of close study by those who are interested in the sale of all kinds of electrical apparatus.

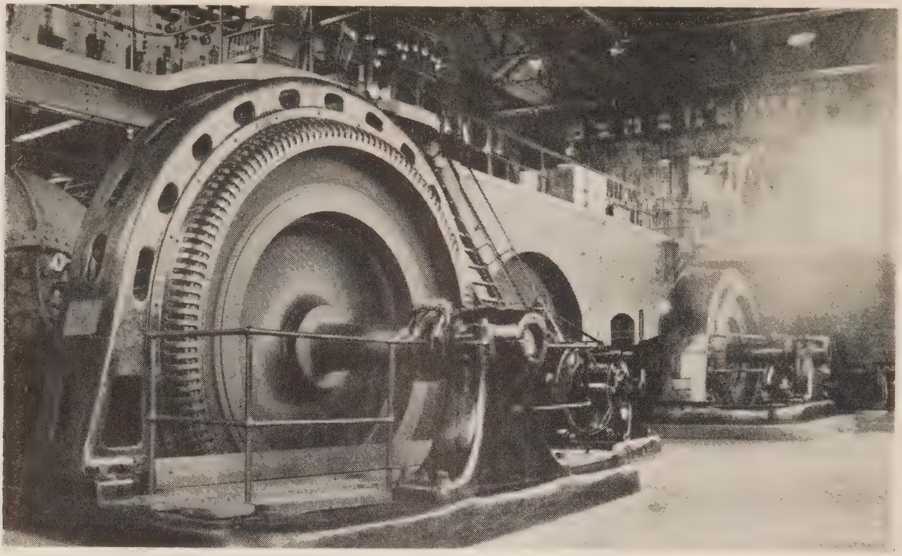
Northern Systems, Sudbury District

By T. C. James, Asst. Engineer, Municipal Engineering Dept., H.E.P.C. of Ont.

THE acquisition of The Wahnapitae Power Co., by the Hydro-Electric Power Commission of Ontario opened up a new field of activity for the Commission in Northern Ontario and assured the mining industry of an adequate supply of power for present and future operations. The Wahnapitae Power Co., therefore, ceased to exist on April 30, 1930, and all of the properties in connection with this company now form a part of the Commission's northern systems, Sudbury District.

The Wahnapitae Power Co. supplied electrical energy to The Mond Nickel Co., The Treadwell Yukon Co., The Falconbridge Nickel Co., and the Town of Sudbury, and as the

Coniston power house, view of down stream end showing outgoing lines, penstock housing, headworks and operator's house.

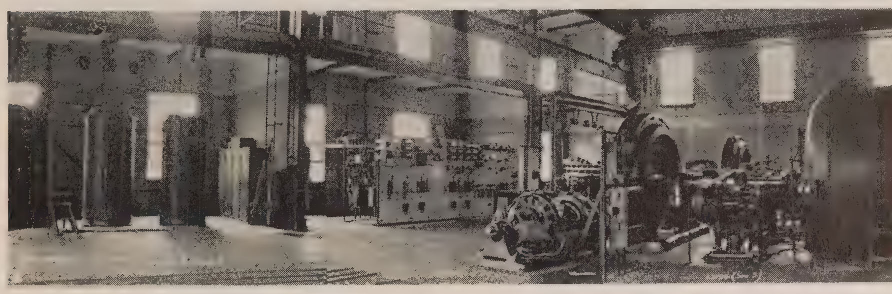


Interior of Coniston power house, showing two of the three generator units and part of the operating gallery.

entire capacity of its generating equipment was practically all contracted for, it became necessary to make provision for an additional supply of power to provide for the growing demands of this most important mining district, and as the mining industry requires large blocks of power, and is of such great national importance, it naturally followed that

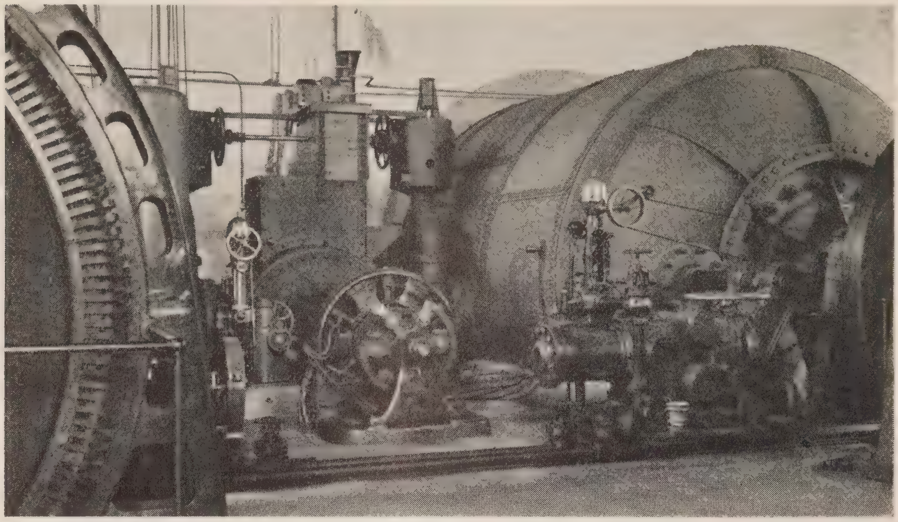
McVittie power house and dam from the down-stream side.

Forebay, McVittie generating station, showing main dam and auxilliary dam.



Interior view of McVittie power house.

Stinson generating station.



Interior view in Stinson power house.

the problem could only be solved by the Hydro-Electric Power Commission taking over the power service for the district, hence, the purchase of The Wahnapitae Power Co. by the Commission, and immediate provision being made for securing additional power.

The Wahnapitae System at present consists of three hydraulic developments on the Wahnapitae River, bearing the names of Coniston, McVittie and Stinson on the Commission's records in place of Plants Nos. 1, 2 and 3, as under the Company's records. The Coniston development, located about 10 miles from Sudbury and adjacent to Coniston, was the first plant to be constructed by the Company, the first unit being placed in operation in 1905. It operates under a 52 ft. head, and consists of three units, one 800 kv-a., one 1,250 kv-a., and one 2,500 kv-a., the total capacity being 4,550 kv-a. The McVittie plant was the second development constructed by the Company, and is located about ten miles down stream from the Coniston plant and consists of two 1,250 kv-a. units, or a total of 2,500 kv-a. It was originally designed to operate under a head of 38 ft., but the actual head varies from 38 ft. to 28 ft. due to river channel conditions below the plant. The Stinson plant, located

Wahnapitae Lake storage dam.

about 8 miles above Coniston, was constructed in 1924, and placed in operation in 1925; it operates under a 54 ft. head and consists of two 2,500 kv-a. units with a total capacity of 5,000 kv-a. The total rated generator capacity, therefore, of the three plants combined is 12,050 kv-a., and the transmission voltage between the development and to Sudbury, and to the various mines, is 22,000 volts. the frequency being 60-cycles. After the purchase of these properties the Commission completed the construction of a storage dam at Wahnapitae Lake for the purpose of improving stream flow regulation, thus greatly increasing both the efficiency and output of the three developments.

As the total plant capacity of these three plants on the Wahnapitae River was only capable of supplying a fractional part of the power requirements in the Sudbury district, the Commission, after making complete surveys and a careful investigation, closed a contract with The Ontario Power Service Corporation for 100,000 horsepower, the power to be obtained from the Company's development now under construction at Abitibi Canyon on the Abitibi River, about 65 miles north of Cochrane. On account of the execution of this contract assistance was given to the pulp and paper industry in the extreme north portion of the Province by making available an additional block of power urgently needed, but impossible to secure at a reasonable rate without obtaining a market for a large portion of the unrequired surplus power at the development. At the same time, an additional source of power of considerable magnitude was obtained and made available for

Site of development, Abitibi Canyon on Abitibi River, before commencement of construction.

the mining industry throughout the whole north section of the Province, and especially at Sudbury, where it was immediately required. Thus, while making it possible for the industries on the James Bay slope to extend their operations, the Commission is also enabled to obtain a supply of power for the Sudbury and intervening mining areas at a price that will permit the future development of the Mississaga water powers without increasing the rates to the consumers. Power will be delivered at Sudbury at 110,000 volts over a transmission line now under construction. A large portion of this power has already been sold to The International Nickel Company, and provision is being made to supply the other mining companies located in the district according to their requirements.

This is the beginning of an extensive Northern System of power development and transmission. The Commission has also in reserve for future development from 100,000 to 135,000 horsepower on the Mississaga River and from 25,000 to 35,000 horsepower on the French River, as well as undeveloped sites on the Ottawa River, all of which is available for the northern systems in the Sudbury District, which covers an area between Sault Ste. Marie and North Bay, and north as far as the Canadian National line running east and west through Cochrane.

Some Specifications, and a Suggestion

By J.H.C.B.

Specification No. 1.

The manager reviles it,
It's sworn at by the works,
The estimator's verdict
This pen description shirks.
And whosoever reads it
Says, as a general rule,
"It's written by an idiot,
And it's printed by a fool".

Specification No. 2.

It's fat and very wordy,
It's full of legal jaw,
It threatens one with penalties
And processes of law.
It wants a ton of samples,
Till one feels, a trifle riled,
That it's written by a father
For a very naughty child.

Specification No. 3.

Like visits from the angels
It comes, if not so rare;
It tells you what you wish to know
Without the aid of prayer.
Its plans are clear and ample,
Its schedules clear and few;
It's written by a man who knows
Just what he wants to do.

The Suggestion

O! prithee, good consultants,
Upon whose words we hang,
To cultivate the Jingle style,
If not the Andrew Lang.
But, should you deem it *infra dig*
To alter what you've done,
Add here and there a Limerick
And here and there a pun.
'Twould help to cheer those pages drear
If sprinkled o'er with fun.

The Electrical Engineer's Ballad Book

Demonstration of Farm Equipment and Household Appliances by the Commission at the Provincial Plowing Match at Stratford, October 14th to 17th

THE plowing match at Stratford this year was reported to be the largest affair of this kind any place in the world. The fine weather and the fact that the location was on a main highway connecting with others leading for long distances in every direction resulted in a very large attendance, which was estimated at 115,000 people, being much larger than that at London two years ago. The entries in some classes were reported as being the largest in the world, two especially being mentioned, that for team plowing in sod in which there were 67 entries and at the same time in another area a tractor class included 40 entries; the winner of one of the major prizes in the latter class was a 16-year old farmer's daughter from east of Toronto.

A city of about 100 tents was created for the purpose of housing the exhibits and cafeterias to serve those attending the match. Of these, 41 were supplied with electric service.

In a conspicuous place in this tented city, located close to the entrance to the grounds and alongside the headquarters tent, was the Hydro tent, which, as in past years, was one of the greatest centres of attraction. Those in attendance estimated that approximately half of all visiting the match, passed through this demonstration. The crowd at times was so great that the attendants

Fig. 1.—The 70 ft. by 40 ft. tent housing the exhibit of household appliances and power-using farm equipment, suggesting applications in the barn and dairy, and for taking care of the water supply.

Fig. 2.—The counter display of household table appliances, lamps, heaters, etc., a variety of washing machines and two radios.

could not leave their stations for hours.

The household section was a centre of attraction for the farmers' wives, and discussion heard in this area indicated that most of them realized what they wanted for the electric service in their homes and that they had considerable knowledge of the advantages of certain kinds of equipment.

In the power-using section, a variety of equipment in each line was set up; water systems, choppers and electric motors. Many of the visitors were seeking advice as to their installations and equipment which they might use. The small chopper

Fig. 3.—A view of the section showing a variety of ranges, rangettes, vacuum cleaners and washing machines as well as the hot water barrel. The equipment is shown in a variety to please taste and pocket.

Fig. 4.—Another view of the same set-up as in Fig. 3, but including refrigerators. Rural residents to-day are as much interested in refrigeration as urban residents.

of the W. C. Wood Company came in for a great deal of attention and discussion as to its ability to supply the needs on the average farm.

A water system for service to the grounds was installed under the supervision of the Commission's engineers; as in the past it has been found necessary to advise the local committee as to water requirements, its

Fig. 5.—The barn section showing some suggestions of using such equipment as might be belted to a line shafting, motor driven, as well as a display of one manufacturer's motor parts.

Fig. 6.—The last word in a grain chopper direct-connected to a motor, with provision on the opposite end for a belt drive to other equipment. This cut also shows a portable motor which apparently is popular on the American side, as well as an assortment of motors and motor parts. The chopper in this display attracted a great deal of attention.

safeguarding and proper installation. In this case water was taken from a creek one mile away from the grounds, two pumps being used, one at the source of supply pumping into a 2 in. main, and the other in the Commission's demonstration tent boosting the pressure and delivering to a secondary system which supplied six taps at various locations on the grounds. The pumps for this system were loaned by the R. A. Lister Company of Toronto, and had a capacity of 1,000 gallons per hour

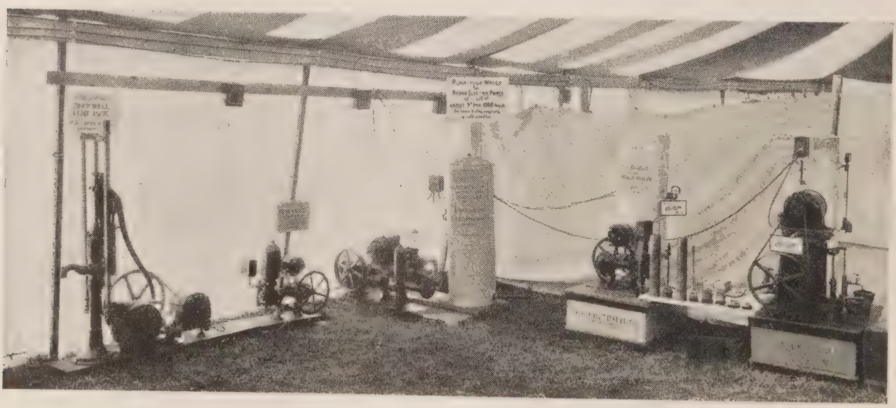


Fig. 7.—Automatic water systems and pump jack. The centre unit was connected with the pump at the source of supply a mile away, to a water system to serve the needs of the large crowds as well as the horses and tractors. This unit had a capacity of 1,000 gallons per hour.

Fig. 8.—Milking machine and cream separator with their individual motor drive. This milking machine used as a means of operating the pulsators on the units, a direct-connected current which was supplied by the small generator to the left of the vacuum pump.

Fig. 9.—Some suggestions of uses of power in a dairy where a line shafting is used. In this case the line shafting is shown with motor drive and the suggested uses include a deep-well pump and washing machine. It has been found that on many farms these uses of power are included with the dairy uses when the dairy is located close to the house.

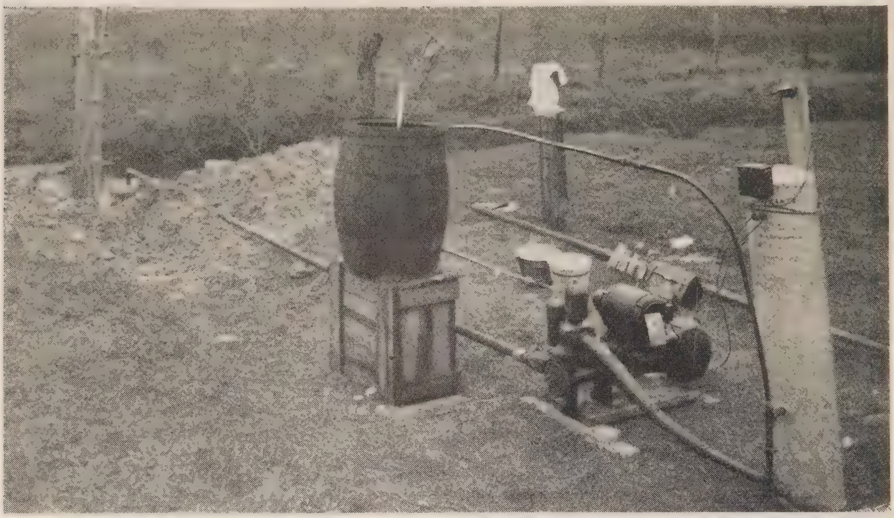


Fig. 10.—The 1,000-gallon, direct-belted, motor-driven pump at the well at the creek, a mile away from the tent city. This pump supplied water to a 2 in. water main from which water was taken by unit No. 2, shown in Fig. 7, and supplied to a secondary piping system which served six taps on the grounds. The supply was safeguarded by chlorination under the supervision of a representative of the Provincial Board of Health at the suggestion of the Commission's engineers.

with pressures varying from 20 to 40 lbs., both being automatic. In order to safeguard the water supply, the Provincial Board of Health was called upon to supervise the installation and operation of a chlorination system. An attendant from that Department was on duty all the time water was being used. The water service from this system was equal to

Fig. 11.—A view showing portion of the city of nearly 100 tents used for headquarters, exhibits and cafeterias.—Province of Ontario Pictures.

any city service, and it was estimated that over 10,000 gallons per day were pumped.

The figures in this article show quite clearly the manner of set-up and the assembly of equipment.

The experience of the Commission in the past has been that demonstrations of this kind with no counter attractions other than the contest itself, have resulted in large extensions of electric service in the districts in which the matches are held.

The Commission wishes to thank those manufacturers, dealers, the Stratford Public Utilities Commission and the local committee for their help and support in making this demonstration so successful.

Foresees Electronic Tube Replacing Many Existing Devices

By Prof. Harold B. Smith

The vacuum tube is rapidly coming out of the category of signalling devices and is developing to a scale where it is capable of handling quantities of power which make it a real tool for the electrical engineer. With tubes now being built with ratings of from 100 to 200 kw. one can see that the electronic era of power equipment is indeed opening up.

Possessing extraordinary versatility in rectifying, converting, changing frequencies, regulating, controlling and performing other complex functions, the vacuum tube presents a new and valuable tool for the electrical engineer in the practice of his profession. It has developed most rapidly within the past ten years, the era of radio broadcasting, as the direct outgrowth of the tremendous volume production of vacuum tubes for radio purposes. Because of this sudden advent, many electrical engineers of the present generation have overlooked its possibilities in purely electrical applications. But the younger group of engineers, particularly those who have had experience in radio, are pressing forward with this vacuum-tube development and the new branch of electronics must soon take its place alongside of and co-ordinate with the older school of electromagnetic machinery.

Not only will the tube supplement and replace tons of moving machinery for converting and transforming power, but it will find uses in switching high-tension currents and as a lightning arrester for protection of lines.

In fact, as the result of the tube's advent, we are likely to witness a complete redesign of our electrical systems in many respects.

The electrical engineer of 1930 is, therefore, giving increasing attention to the whole field of electronic action in vacua, for through the developments here being made he foresees the even wider expansion of the instrumentalities with which he works.

—*Electrical World.*

O.M.E.A. - A.M.E.U. CONVENTION

at the Royal York Hotel, Toronto

JANUARY 27th and 28th, 1931

Association of Municipal Electrical Utilities

MINUTES OF EXECUTIVE COMMITTEE MEETING

A meeting of the Executive Committee of this Association was held at the office of the Hydro-Electric Power Commission of Ontario, Toronto, on the afternoon of Friday, October 10th.

The meeting was called to order at 2.00 o'clock by Mr. R. L. Dobbin, President.

The following members of the Committee were present: Messrs. J. E. B. Phelps, J. E. Teckoe, R. M. Bond, E. V. Buchanan, J. R. McLinden, C. T. Barnes, J. W. Peart, R. J. Smith, T. W. Brackinreid, T. J. Hannigan and S. R. A. Clement.

It was moved by Mr. E. V. Buchanan and seconded by Mr. J. R. McLinden, that the Minutes of the Summer Convention, as published in the *Bulletin*, be taken as read.—*Carried*.

These Minutes contained a resolution introduced at the Accounting and Office Administration Session of the Convention recommending to the Executive of the Association that a Standing Committee be appointed to consider matters pertaining to accounting and office administration, and the joint operation of utilities. Mr. T. W. Brackinreid gave notice that at the Winter Convention he would move;—

"THAT the by-laws be amended by the insertion in Clause 7, Standing Committees, Paragraph 'a'—

"8. Committee on Accounting and Office Administration."

A letter from Mr. R. V. Slavin, Sales Manager, Winnipeg Hydro-Electric System, with reference to the possibility of this Association branching out and taking in members from municipally owned utilities in Western Canada, was read.

It was moved by Mr. J. E. B. Phelps, and seconded by Mr. C. T. Barnes, "That Mr. Slavin be asked to come to our Winter Convention and attend the meeting of the Executive Committee at that time for the purpose of discussing his suggestion."—*Carried*.

Referring to a letter from Mr. T. J. Hannigan, Secretary, O.M.E.A., in which he reported progress as a result of a resolution from this Committee passed at its meeting on April 23rd, Mr. Hannigan advised that he believed a complete reply would be given in the Secretary's report of that Association to be presented at its annual meeting, concurrent with the Winter Convention of this Association.

A letter from Mr. C. K. Howard, Manager, Tourist and Convention Bureau, Canadian National Railways, bidding for the Summer Convention at the Chateau Laurier, Ottawa, was received.

A letter from Mr. W. B. Buchanan, Testing Engineer, Hydro-Electric Power Commission of Ontario, in reference to the working of and representation on the National Research Council on "Electric Meters and Metering Methods", was read.

It was moved by Mr. E. V. Buchanan, and seconded by Mr. J. R. McLinden "That this letter be referred to the Regulations and Standards Committee."—*Carried*.

The Treasurer reported the Association to have a total of $2,014.00 of Association money on deposit in the

bank and suggested that he be instructed to invest some of the same in bonds.

It was moved by Mr. R. J. Smith and seconded by Mr. J. R.McLinden "That the Treasurer invest $1,000.00 in bonds of the Province of Ontario bearing an interest rate of 5%." —*Carried.*

Letters were then read from the Managers of the Royal York Hotel and the King Edward Hotel, bidding for the Winter Convention of the Association. It was pointed out that it was desirable to hold this Convention to coincide with the weekly luncheon of the Electric Club of Toronto which would be held on January 28th, when the speaker is to be Mr. L. A. Hawkins, Executive Engineer, Research Laboratory, General Electric Company, Schenectady, N.Y., and his subject, "Research and its Relation to the Public". The King Edward Hotel reported that such date was not available, while the Royal York Hotel advised that the Association could be accommodated on January 27th and 28th.

It was moved by Mr. J. W. Peart and Seconded by Mr. J. E. Teckoe "That the Winter Convention of the Assocation be held at the Royal York Hotel on January 27th and 28th, 1931."—*Carried.*

Mr. E. V. Buchanan, Chairman Papers Committee, presented a report from that Committee suggesting papers to be given at the Winter Convention and moved "That it be received and adopted." On being seconded by Mr. C. T. Barnes, Mr. Buchanan's motion was *Carried.*

In discussing Mr. Buchanan's report it was felt that an effort should be made to allot more time to the discussion of papers. It was, therefore, moved by Mr. J. R. McLinden, and seconded by Mr. J. E. Teckoe "That the Business Session of the Association be held on the first morning of the Convention, beginning at 10.30 o'clock, and the other Sessions as formerly held be devoted to papers and to discussion."—*Carried.*

Referring to the Accounting Session held at the Summer Convention, it was felt that this should also be continued and Mr. Bond was instructed to proceed with its arrangement.

In discussing the question of entertainment during the Convention luncheons and dinner the following resolution was endorsed:

MOVED by Mr. J. W. Peart, and seconded by Mr. C. T. Barnes, "That Mr. C. A. Magrath, Chairman of the Hydro-Electric Power Commission of Ontario be respectfully urged to attend the Winter Convention of the Association and be guest speaker at the Convention dinner to be held on the evening of January 27th jointly with the O.M.E.A." —*Carried.*

The meeting adjourned at 4.15 p.m.

A. G. Hall Honoured

Arthur G. Hall, Chief Electrical Inspector of the Hydro-Electric Power Commission of Ontario, was elected President of the Western Section of the International Association of Electrical Inspectors at the 27th Annual Convention held in the Congress Hotel, Chicago, on September 15th, 16th and 17th. Mr. Hall is well known to the Electrical industry, both in Canada and the United States. He has been with the Commission for seventeen years and has been Chief Electrical Inspector for the past ten years. At the present time he is chairman of the Ontario Committee on the Canadian Electrical Code and is also chairman of the Panel on Interpretation of the Code. In addition to this, he is serving on several Article Committees as well as on the Electrical Committee of the National Fire Protection Association. He is the first Canadian to have had the honour of the presidency of the Western Section conferred upon him.

W. V. Bishop, H.E.P.C of Ont., Toronto

Wallace Vernon Bishop

It is with extreme regret that we refer to the tragic and untimely end of a member of the Commission's staff, in the person of Wallace Vernon Bishop, on the morning of Saturday, October 18th.

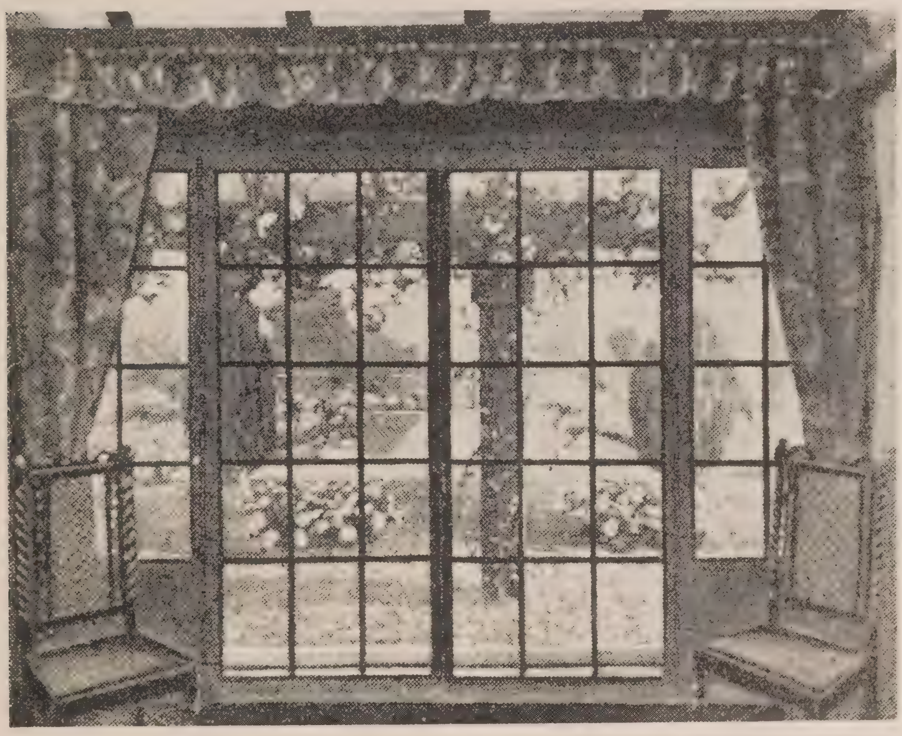
A party of five, including Mr. Bishop, had gone duck hunting in the ice areas at the south-westerly portion of Cook Bay, Lake Simcoe. They arrived at the hunting-ground from Elmhurst Beach on the eastern side of the Bay at daybreak, and three of the party, including Mr. Bishop, were returning to their starting point, about three miles distant, along about ten o'clock when they ran into rough water, caused by high winds which had developed as the day advanced. When within about half a mile of their destination their canoe swamped, upon which Mr. Bishop, being a good swimmer, struck out for shore. One of the party, clinging to the canoe drifted to shore and broke the news of the accident to some men working on the beach. The third party in the canoe, who was suffering from injured arms, also started to swim to shore but disappeared under the water soon after.

Mr. Bishop was born at Kimberley, Grey County, Ontario, and attended Meaford High School. In 1922 he graduated from the School of Practical Science, University of Toronto. In 1923 he joined the staff of the Hydro-Electric Power Commission of Ontario as draftsman on station design in the Electrical Engineering department. From there he was transferred

to the Municipal Engineering department, where he served up to the time of his death.

Outside of his work, Mr. Bishop took an active interest in athletics and was considered very proficient in the many fields of sport in which he took part.

Mr. Bishop is survived by his parents, Mr. and Mrs. W. S. Bishop of Aurora, Ontario, his wife, Beatrice Dixon, a daughter of Mr. A. N Scarrow, Toronto, and two small children, to all of whom we extend our most sincere sympathy in their bereavement.



Illumination of Painted Garden Scene. The scene is erected between the window and a wall which would otherwise obstruct the view from the window—The Times Trade and Engineering Supplement.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

Hydro News Items

Eastern System

The City of Peterborough experienced a serious interruption owing to a heavy short on the lead covered underground cables between the sub-station and the overhead distribution system. The cables are now being replaced but there is considerable doubt as to the origin of the short circuit.

* * * *

A new transformer station consisting of one three phase, 750 kv-a., transformer with provision for a second 750 kv-a., transformer is under construction. This station which is located approximately at the load centre of Trenton is being equipped with automatic re-closing feeder switches and will be ready for service at an early date.

* * * *

The Field Farm Milling Co., a new industry in the village of Norwood, is now in operation, with a load of about 95 h.p. This Company manufactures "Worthmore Feeds".

* * * *

Georgian Bay System

Mr. J. A. Wanamaker, who has had extensive experience with the Commission, having been employed by the Operating and Construction Departments, has recently been appointed Rural Superintendent, stationed at Port Carling. He will have jurisdiction over Beaumaris and Utterson Rural Power Districts, as well as the villages of Port Carling and Windermere.

* * * *

Niagara System

Thirty-one rural consumers formerly served from the lines of the Fergus distribution system were tied in with the Elora rural power district lines on October 1, 1930.

* * * *

The rural transformers in the Preston H. T. station were recently changed from 3–150 kv-a. to 3–250 kv-a. capacity, owing to the increased rural load in the Preston rural power district.

* * * *

A fourteen-mile rural line between Goderich and Dungannon serving forty-two consumers was recently placed in operation. As power in Goderich is 2,200 volts a 37.5 kilowatt, single-phase, 2,200/4,400-volt transformer was installed in order to step up the voltage for rural distribution.

* * * *

The annual Provincial Plowing Match was held on October 14-17, between Stratford and St. Marys. The exhibit by the Hydro-Electric Power Commission of Ontario, demonstrating the application of Hydro to farm work, was a feature. Power was supplied from the lines of

the St. Marys rural power district. The transformers and the distribution system throughout the grounds, supplying service to forty-one exhibitors, were erected by the staff from our Mitchell office. Engineers from the Commission were on hand to explain details in connection with the application of Hydro power to farm work. Detailed information regarding the exhibit is given in an article in this number.

* * * *

On Sunday, October 26th, the voltage supply for Glencoe was changed from 4,000 to 8,000. This change was found necessary to take care of an increasing load in this municipality and the surrounding rural district.

The Bothwell Distribution Station transformers, 3–75 kv-a., 26,400/4,600 connected delta on primary and grounded Y on secondary, were tested out on the above date. This station will supply the urban Hydro municipalities of Newbury, Wardsville, and Glencoe, as well as the Bothwell R.P.D.

* * * *

On October 26th the 3–75 kv-a., 4,000/4,600 volt Strathroy Rural District station transformers at Strathroy to step up the voltage from 4,000 to 8,000 were tested out. On account of the distance and loads to be served in this rural district it was found advisable to change to 8,000 volts for distribution.

* * * *

Mr. Dalton Smith, formerly of the London Rural District, has been appointed Superintendent of the Dutton Rural Power District and an office has been opened in the centre of the rural district at West Lorne. The Commission have been requested by the West Lorne Hydro-Electric Committee of Council to operate the urban municipality of West Lorne. On each side of West Lorne are the Hydro urban municipalities of Rodney and Dutton and the Dutton Rural Power District field staff will also be able to assist in remodelling, maintaining, and operating their electrical distribution systems.

Correction

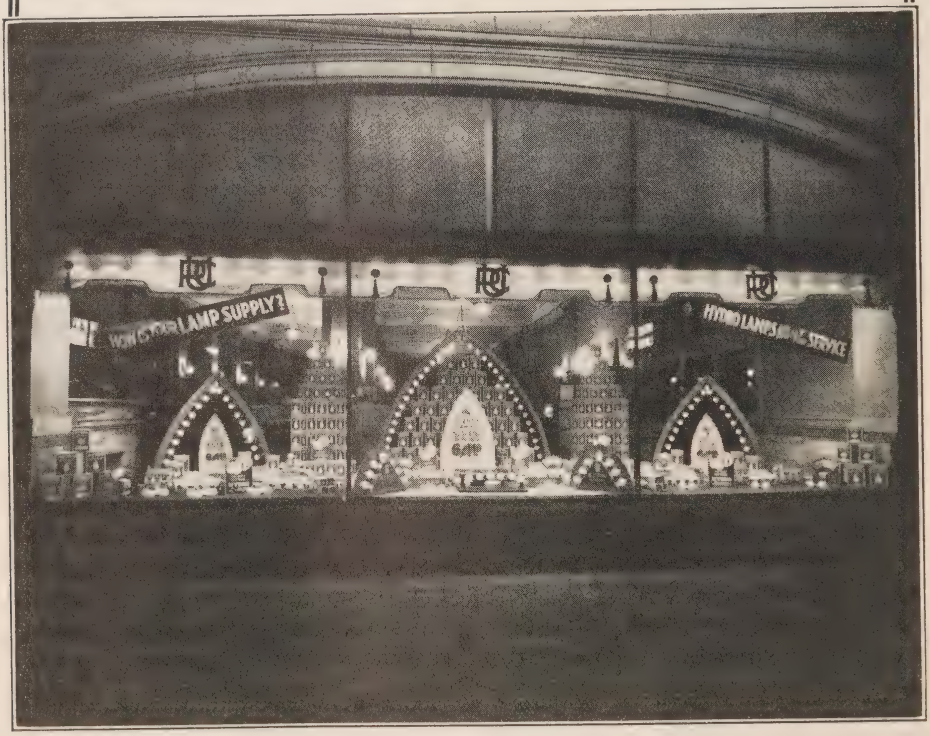
The last paragraph of the article copied from *The Travellers Standard* entitled "The Electrical Hazard in Fire Extinguishing" and appearing in the September *Bulletin* states: "Although a current of at least one-tenth of an ampere (and probably considerably more in the average case) is necessary to cause death, as little as .02 of an ampere is quite painful, and a current of .05 of an ampere is almost unbearable". Dr. M. G. Lloyd, Chief, Section of Safety Standards, Bureau of Standards, Department of Commerce, Washington, writes: "The data available to me indicate that 100 milliamperes through the vital organs represents sure death, and as little as 25 milliamperes may be fatal."

Recognizing the fact that absolute statements cannot be made as to the amounts of current that may or may not be fatal to human beings at this time, and that very small amperages are extremely dangerous, *The Bulletin* has considered the article to contain a warning worthy of passing on to its readers while leaving the responsibility of the statements contained in it to the author.

Hydro Lamps

are the choice of Hydro Lighting Customers

Hydro shops should all PUSH their sale as vigorously as is manifested in the illustration below.



London Hydro Shop Window

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Control Room Lighting

By C. B. Stephens, Asst. Engineer, Electrical Engineering Dept., H.E.P.C. of Ont.

AS a control room is the nerve centre of an electrical supply system it requires light, twenty-four hours each day, of a quality somewhat dependent upon the importance of the service rendered by the system. For instance, the control room of an important generating or transformer station demands a higher quality lighting system than that required by a distributing station comprising incoming lines and local feeders only. In the former cases the switching operations are more involved and generally more frequent than in the latter.

Twenty-four hour lighting service in some control rooms includes natural lighting during the daylight hours, while in others electric lighting is used entirely. From the quality viewpoint electric lighting is to be preferred due to its reliability, whereas natural lighting is not dependable. The apparent daily journey of the sun produces a constantly changing direction of incident light besides the added variable factor of clouds or fog. It is evident, therefore, that electric lighting is to be preferred, especially in control rooms of important stations.

There is, however, a reluctance on the part of building designers to dispense with natural lighting entirely, due partly to the accepted necessity of having windows in a room, inherited, no doubt, from the fact that windows have been used for generations, and due partly to our being accustomed to live in rooms admitting daylight. Is it not probable that in the future "manufactured weather" plus suitable light sources emitting ultra-violet light will evolve a better control room than can be had by present construction methods? Open windows always have the habit of letting more dirt into a room than the size of the windows would seem to warrant, besides disorganizing the heating or cooling systems.

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The outstanding requirements of control room lighting are:

(a) Plenty of light — not just enough to see by.

(b) Freedom from annoying shadows.

(c) No appreciable glare either from the light sources or reflecting surfaces. (This requirement also applies to natural or daylighting, but it is difficult to apply with entire satisfaction.)

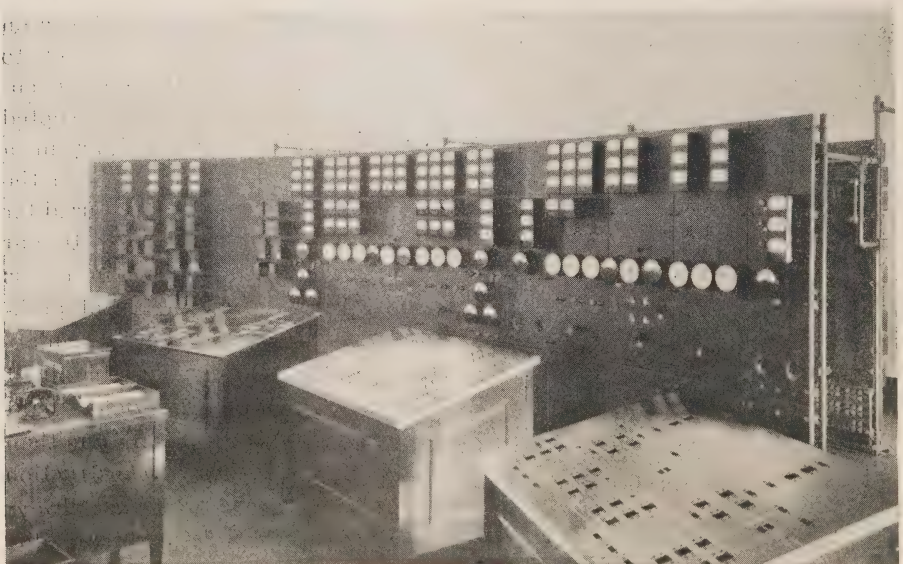
(d) Good diffusion and fair uniformity of intensity on both horizontal and vertical surfaces.

(e) Reasonable power consumption consistent with the service required.

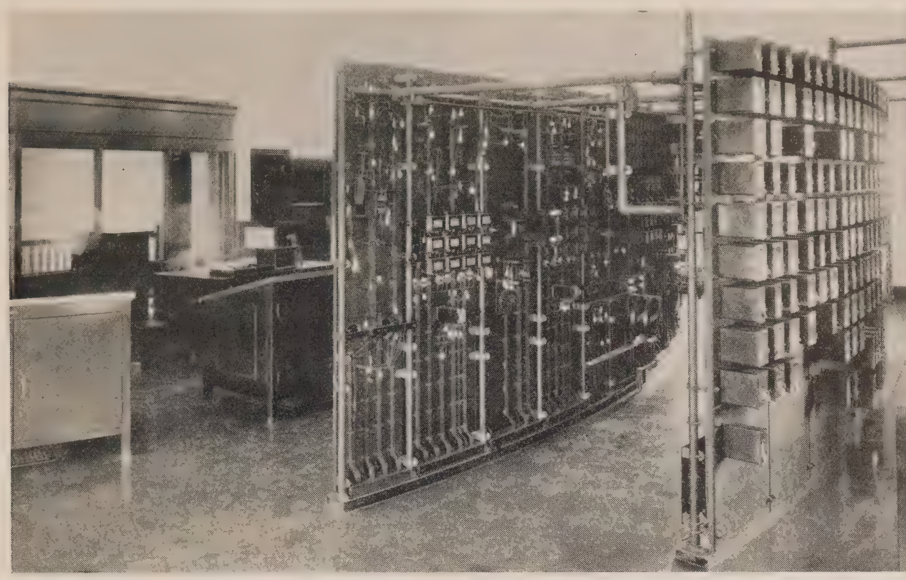
(f) Ease of cleaning and lamp replacement.

(g) Ability to maintain the system at about its original quality. This includes keeping the light controlling equipment in proper adjustment.

(h) Low depreciation of light controlling equipment other than obsolescence.



Toronto-Leaside transformer station control room. showing the excellent lighting obtained with indirect units which are so inconspicuous they can hardly be noticed in this photograph against the white ceiling.



Showing how the details can be easily seen at the backs of the relay and meter boards in the Toronto-Leaside transformer station. The lighting units are totally indirect.

(i) Provision for emergency source of energy in case of failure of the regular service.

These requirements are most nearly realized by the use of totally indirect lighting which implies that the light sources or lamps are so arranged that none of the direct light is used but most of the light is distributed over the ceiling. The reflected light from the ceiling constitutes the useful light in the room.

Another method of lighting which has been tried with reported success might be called controlled direct lighting. This method employs flat prismatic glass lenses, suitably enclosed, at or near the ceiling line, and through which light is transmitted and directed towards the various control panels or relay boards. A few installations of this equipment have been made but the writer has had no actual experience with such equipment.

Two of the accompanying views illustrate the indirect lighting in the control room of the Toronto-Leaside transformer station. Here twelve 500 watt silvered glass lighting units are utilized with fairly satisfactory results. The view of the relay panels and the rear of the indicating panels shows the visitors observation window. Above this window and concealed from view is a bank of silvered glass indirect lighting units for emergency lighting supplied from the station control battery. At various times daylight interferes with the satisfactory lighting of the room; for instance, the late afternoon or early morning direct sunlight causes undesirable side lights. Although these views were photographed in daylight it is readily observed that

Method of indirect lighting used in Strachan Avenue transformer station, Toronto.

daylight alone will not afford adequate illumination even during the brightest hours. The horizontal shadows at the meters came from the daylight through the side window.

Another view is that of the control room of the Ontario power plant of the H.E.P.C. at Niagara Falls. The lighting equipment here has only been in service for a few months,

The control room at Ontario Power generating Station, Niagara Falls.

having replaced an obsolete system. There are nine lighting units, each equipped with 1,000 watt lamps, and prismatic glass reflectors, the latter being chosen in an attempt to obtain sufficiently white light to distinguish the colors on the dummy bus sections. The ceiling is painted white and the walls are of light shades to improve the general lighting effect and facilitate color discrimination. In this example the window area is insufficient to allow adequate daylighting even during the brightest days. Direct current is utilized from service machines so that emergency circuits are unnecessary.

A rather unusual example of lighting is seen in the accompanying views of the control room of Strachan Avenue transformer station at Toronto. The lighting here was installed last spring to replace inadequate direct lighting equipment. Due to the height of the ceiling above the beams on which the lighting units were to be placed, intensive type prismatic reflectors were chosen and nested in metal spinnings to eliminate all direct light. Eight 500 watt units are grouped on the horizontal beams adjacent to the column near the middle of the room. One unit is mounted on another beam at the far side of the room. One wide beam prismatic glass unit attached to the underside of the transverse beam affords a degree of emergency light from the station control battery. At the time of installation of the new lighting the entire room was repainted, a light cream color predominating. — *Electrical News and Engineering.*

Guelph Transformer Station Extension

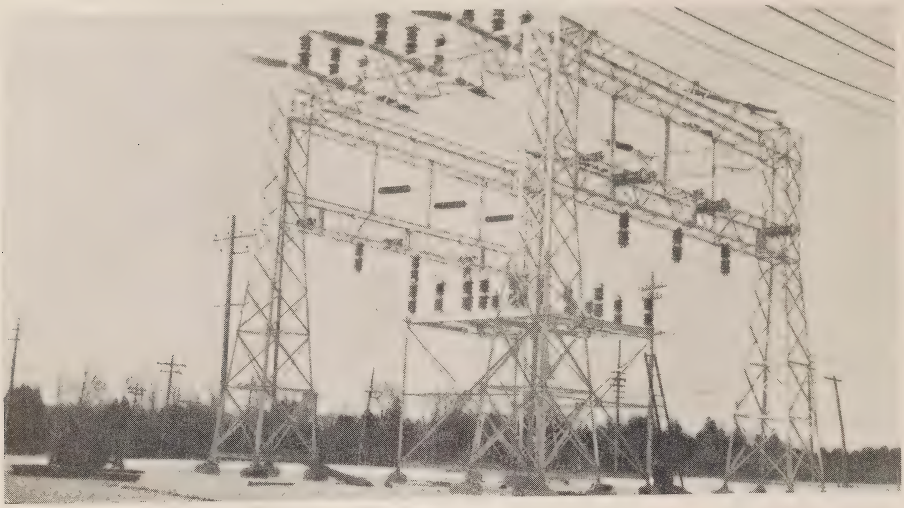
By B. C. Platt, Asst. Engineer, Electrical Engineering Dept., H.E.P.C. of Ont.

DUE to increasing load conditions it has been necessary to provide additional transformer capacity and heavier duty 13.2 kv. oil breakers at the Guelph Transformer Station.

The 110 kv. type "GA" line breakers were removed from inside the station and replaced by motor-operated, swivel type, horn gap disconnecting switches installed outdoors on a steel structure which was erected to accommodate one 110 kv. line which was swung around the north side of the station.

The new transformer bank consists of three 2,500 kv-a. transformers of Westinghouse manufacture which were installed as a second bank in new pockets in the existing high tension room in the space vacated by the 110 kv. line breakers. The station now has an active transformer capacity of 15,000 kv-a. with a spare 2,500 kv-a. unit which is so connected that it may be used with either bank in case of failure to any of the transformers.

The 13.2 kv. switching equipment was re-designed using an open type



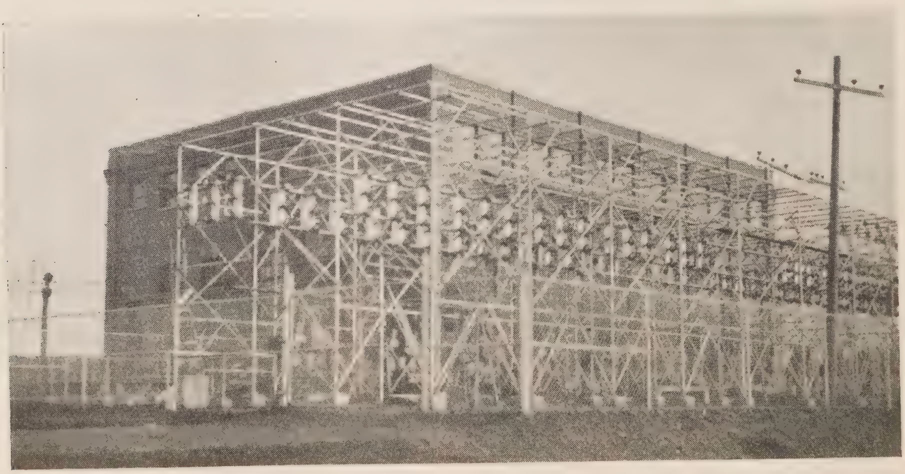
Outdoor, 110 kv., switching structure.

of bus and new type "CH-1" Westinghouse oil breakers which were installed outdoors.

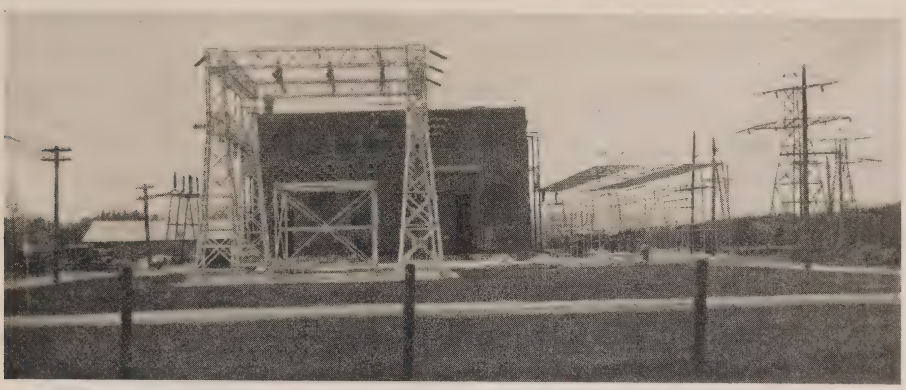
An emergency 13.2 kv. bus was provided which was connected to the main bus through an emergency oil breaker.

To accommodate the installation of the new equipment outdoors, a pipe structure was erected. This structure is 124 ft. long, 28 ft. wide and 20 ft. high. It consists of 2 inch and 1¼ inch pipe, of which there is approximately 2 miles used in its erection. All of the oil breakers are electrically operated, a 60-cell, type "EOGO-9" Exide battery being installed in conjunction with a 2 kw. diverter pole motor generator set.

A new control room was erected



Outdoor, 13.2 kv. switching structure.



During construction of outdoor structures.

under the old lightning arrester gallery, the floor of which was extended 18 feet, making the control room approximately 60 feet long.

Improved relay protection was provided on both transformer banks, the 13.2 kv. busses and all 13.2 kv. feeders. Three single pole oil breakers of Canadian General Electric manufacture were installed as a ground selector. Each single phase breaker is connected between phase and ground through a water resistance. Upon the occurrence of a ground fault, the unbalanced ground voltage thus created on the three phases is made use of to select and close one of the ground switches of an opposite phase, thus completing a single phase short circuit by way of a ground fault. The fault current thus created will trip the faulty feeder.

This work has been carried out by the Commission's Construction Department and was placed in service on November 2nd, 1930.

Permissable Errors in Synchronizing Generators

By H. S. Baker, Meter Engineer, H.E.P.C. of Ont.

WHEN an a-c. generator is synchronized to a bus there are two kinds of error, both generally present.

One error is the number of electrical degrees of phase difference between the generator and bus at the instant of breaker closure.

The other is the difference in speeds of the generator and bus. This difference in speeds is expressed in cycles per second. A difference of say one seventh of one cycle per second will produce one revolution of the synchroscope in seven seconds, and so on.

After the breaker has closed (connecting the generator to the bus), a more or less continued oscillation occurs which is analogous to the swinging of a pendulum, or the

oscillating of a mass under the influence of a force which varies directly as the displacement of the mass from some fixed point. This oscillation of the generator has a very definite time period which can be measured by a stop-watch when observing the generator kw. meter after synchronizing.

The power flow is at a power factor close to unity, if the voltages were equal before breaker closure. The reason for the power flow being at a high power factor is as follows.

The net voltage tending to urge current to flow is the vector difference between the generator and bus voltages. This difference, being the line segment joining the points of the two vector arrows, is nearly at right angles to the arrows themselves. This quadrature voltage, urging current through an almost pure reactance, causes a current flow at right angles to itself, which is therefore nearly in step with the original voltages, or the power factor is high.

The value of the momentary rush of kv-a. (which in this case is kw. as stated above) is governed by the electrical degrees error at the instant of closure, and is proportional to the cord of the arc of the angle of error.

The amount of current flow is also dependent on the inherent reactance of the generator plus bus, or is, in other words, dependent on the momentary percentage reactanc eof the generator plus bus.

For a 60 degree error, the cord of the arc, or the vector difference in voltages is of the same value as either of the voltages alone, hence the kv-a. rush is the same (assuming the reactance of the bus is zero) as though the generator were shorted at its terminals.

Should one generator be closed onto a bus of say four similar generators, then the reactance of generator plus bus would be 5/4 of the reactance of the generator alone, or the 60 degree rush would be 4/5 of the momentary short circuit of the generator alone.

For other errors than 60 degrees the rush can be calculated from the length of the cord of the arc.

For the varying values of kv-a. flow during the oscillations, the fact that the power factor is high, means that the armature reaction demagnetizing effect in the generator is small, and for the present argument it will be assumed that the inherent reactance alone is the reactance governing current flow. This means that the momentary percentage reactance of the generator is applicable, not only at the moment of closure, but for all later values of kv-a. transfer during the oscillations. We will then say that (for small angular errors) the kv-a. or kw. transfer is at all times proportional to the angular difference between the generator and bus.

Now the torque exerted to bring the generator in step with the bus is measured by the kw. transfer, or is measured by the angular displacement, hence we have the case of the restoring force being always proportional to the displacement, and we can proceed to develop an analogy to the simple harmonic motion of the oscillating mass.

It is true that there is a more or less rapid decrement to the swings but for the first two half swings this will be neglected.

In one design of generator there are only about ten noticeable double swings, while for another design the swings continued for 2½ minutes.

The following two equations of simple linear harmonic motion will be quoted as fundamental laws of kinetics.

$$t^2 \text{ equals } \frac{1.22\ W}{F} \qquad (1)$$

$$D^2 \text{ equals } d^2 \text{ plus } \frac{W v^2}{32.2\ F} \qquad (2)$$

Where t equals seconds per double swing.

W equals the mass in pounds of the oscillating body,

F equals the value of the centralizing force in pounds weight at the instant when the displacement is one foot.

D equals the maximum displacement in feet during the oscillation.

v equals a momentary velocity of the mass in feet per sec.

d equals the momentary displacement of the mass in feet, at the instant when its velocity was v.

In a certain generator the moment of inertia of the rotor was calculated to be 5 x 10^6 foot-squared-pounds, or the rotor could be considered to be a concentrated mass of 5 x 10^6 pounds at one foot radius from the centre of the shaft.

The time of one double swing after synchronizing was observed to be 1.29 seconds.

These values substituted in equation 1 give the value of F as 3.66 x 10^6 pounds per foot of displacement.

As the generator in question had 16 poles, then one revolution was 8 cycles. The travel of the mass at one foot from the centre (per revolution) was 6.28 feet.

One foot travelled was then equal to 1.275 cycles.

A velocity of one foot per second was a difference in speeds of 1.275 cycles per second.

Before proceeding to apply the above values in equation 2, we will determine the maximum allowable angular difference between the generator and the bus during oscillations following closure to the bus. This maximum angular difference occurs at the end of a swing, where the value of d is D.

It will be seen by equation 2 that a given angular error at closure and a given speed difference error will produce a certain maximum value of swing, D, whether the speed difference is tending to decrease, or to increase the angular error at the instant of closure.

Let us say that the greatest allowable value of D is such as to produce say 10,000 kw. interchange of power between generator and bus, following synchronizing.

The generator in question had a momentary percentage reactance, (based on 10,000 kv-a.) of 13 per cent. This means that the generator if closed to a bus of four similar generators at 60 degrees error would transfer 4/5 of $\frac{10{,}000}{.13}$ kv-a. or 61,500 kv-a. Taking now the angle whose cord is 10,000/61,500 of the cord of 60 degrees, we find the value of D in

electrical degrees is 9.3 degrees or .0258 of one cycle or .0258/1.275 foot, or 0.020 foot of displacement.

We can now substitute in equation 2 as follows—

D equals 0.020

W equals 5 x 10^6

F equals 3.66 x 10^6.

and we get

0.0004 equals d^2 plus 0.0425 v^2.

This gives a curve of d versus v for given maximum swing D. We can then convert the values of d from feet into electrical degrees, and convert the values of speed difference, v, into cycles per second, and we get the following pairs of values, any of which will produce a value of D equal to 0.02 foot, or 9.3 electrical degrees and in turn produce a maximum kw. transfer of 10,000 kw.

These figures mean that if the speed difference be zero, then the maximum permissable angular error is 9.3 degrees. If the angular difference is zero, then the maximum permissable speed difference is 0.123 cycles per sec.

For a speed difference of 0.121 cycles per sec. the angular difference at closure must not exceed 2 degrees.

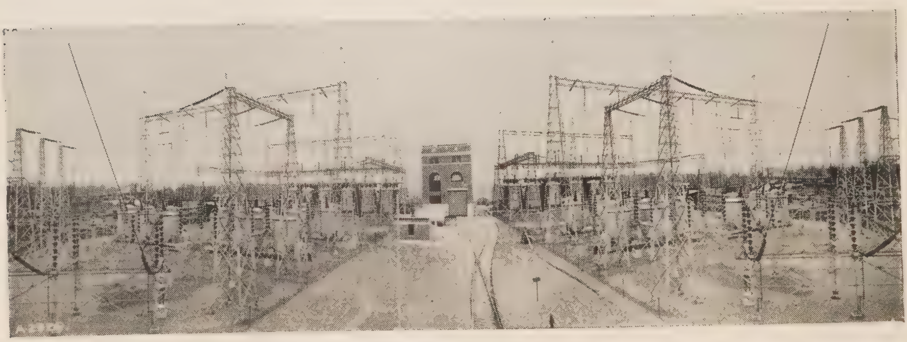
The curve of d versus v is an ellipse with its centre at the origin.

The performance of automatic synchronizers can be expressed as a curve of degrees error in synchronizing for given speed differences existing between generator and bus.

This curve of performance must lie entirely within the above ellipse which represents the maximum allowable kw. transfer following synchronizing.

The pairs of values are—

d, in electrical degrees—	0	2	4	6	8	9.3
v, in cycles per sec.—	0.123	0.121	0.113	0.093	0.060	0



Water—What does it Really Cost?

By E. R. Meacham

DOWN in the low country, between Charleston and Beaufort, down where Four Hole Creek ambles out to the sea, there is a little negro church where Brother Mose Allen coaxes and scolds his flock into the way of righteousness. One night he finished up a sermon with the dramatic assertion :

"Salvation am free!"

Then he sat down and wiped his shiny black brow with a spotless handkerchief. But he had to get up again directly and ask the usher standing importantly at the door to take up the collection.

"How cum you takes a collection Brudder Mose?"

The interruption came from a group of well-dressed town negroes in one corner of the tiny church.

"You all jus' say salvation am free and then you ask us to pay for it."

Brother Mose jumped up, his black eyes sparkling.

"Dat all right, Neb. Dat all right. Yo' Mammy goes down to the creek and gets the water every day that comes. She don' haf to pay for it. That water am free jus' like salvation. But off yonder in Charleston, you gets your water from a tap, and—water or salvation—when you gets it piped to you, you has to pay for it."

It goes farther back than that. Every pail of water that comes into our houses costs something and we have to pay its price in coin of one sort or another.

The Jim Hortons live on a comfortable 160-acre farm in Ohio. They have five children, two of them are in school; the other three are still babies, one in the cradle, the others at the mud-pie age. Most of the time Bess Horton carries the water herself, 40 gallons of it a day, from the pump four rods back of her kitchen door.

That seems like a lot of water. I said so doubtfully when I was talking with her one day. She laughingly replied :

"It takes a heap of water in a house to make it home, if Edgar Guest will forgive me saying so."

Individual Consumption

And I found she was really quite economical when I studied the tables in a recent bulletin on "Water and Plumbing Systems for Farm Homes", published by the University of Illinois. There Professor E. W. Lehmann says they have found that when water is carried in by hand, it takes from six to eight gallons a day for each person in the family; when there is a pump at the kitchen sink, that amount goes up only two gallons a day; but when there is running hot and cold water in the kitchen, it goes up to fifteen to twenty gallons, and when there is a complete plumbing system in the house, with lavatory, bath and toilet, as well as the kitchen sink, each member of the family may use as much as twenty to forty gallons a day.

So Bess Horton was keeping even below the average with her forty gallons for seven people.

Water Needed Regardless of Weather Conditions

It did not cost so much to bring in a pail of water on a pleasant spring

morning, or on the first crisp days in the fall. But her family needed water whatever the weather. Fair days or foul, she had to spend at least half an hour a day as water boy. That cost quite a little in time in the course of a month. It cost considerable strength, too, to pump and lift, and carry 40 gallons of water. Sometimes it cost a little bit of her good temper, too, particularly when, with only half an hour to get dinner, with the telephone ringing, and the baby crying, she discovered that the water pail was empty.

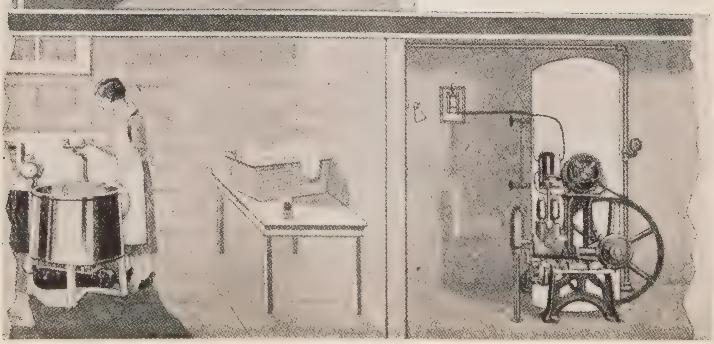
The cost of a pail of water, then, must include all three: time, strength, good temper.

Mrs. Horton has not had a vacation for four years, but she has been spending eighteen days of ten hours each carrying water every year. When her husband put in an automatic water system this last summer, he made her a present of those eighteen days a year, for the rest of her life. Perhaps she cannot take them to do with as she will; perhaps she will have to spend them right on the farm where she is, but at any rate, she will not spend them with a water pail in her hand.

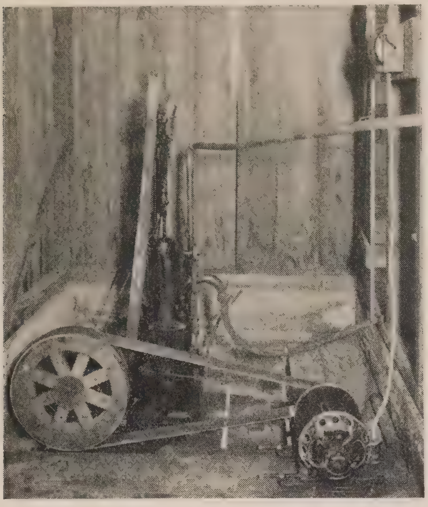
Meters Figure Cost

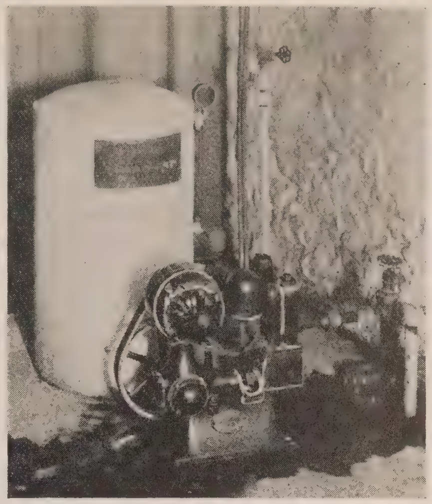
I have never seen any figures on what it costs in money to supply a family with water by the pail. It is far easier to figure it out when electric rather than human power does the job. We have meters for that.

But there has been a decided lack of definite figures on the first cost of a farm water system all complete and ready to furnish water for house and



A suggested layout for water service in a home, with the automatic pumping equipment and pressure tank located in the basement—laundry tubs in the basement, sink in the kitchen and bathroom on the second floor.





The cut on the left shows a deepwell automatic pumping equipment in the well house on a farm in the Woodbridge R.P.D. This equipment, in addition to supplying hard water to the barns, takes care of the hard water needs of the house. The cut on the right shows the equipment for taking care of the soft water supply for the house only.
In winter weather when the furnace is in operation, in addition to having cold soft and hard water, there is hot soft water for kitchen and bathroom service.

farm. The reason is clear enough. No two systems cost just the same when you get them installed. Conditions, distances, the depth of wells, all are different. One recent bulletin from Nebraska makes the cautious statement that such a system would have to be very elaborate indeed to cost as much as the cheapest new car on the market.

So it is not because water systems actually cost so much that the bucket brigade still has so many members. But the car is a complete unit, already assembled, just like thousands of others, and ready for use the instant it is purchased at a definite and widely advertised price. While the water system, though much cheaper, must too often be planned, assembled, even installed, by the purchaser himself.

During the past summer one power company in the middle west sold water systems all wrapped up and delivered at the kitchen sink. They quoted installed prices. These were not uniform of course, for the demands and conditions of one farm differed from those on the next. But they met with the farmer, planned the layout, found out just how much, if any, of the labor he would like to do himself, agreed on the size of the pump, the motor, and the tank, and decided what accessories, such as furnace coils, and softeners the company should furnish. Then they told him to the penny what the system would cost him.

I went out to see some of those water systems in operation last week. The first one I saw was on the farm of

A. Averbeck, near Van Dyne, Wisconsin.

The Averbecks have a well with the water so close to the surface that they can use a shallow well system. They put it down in the basement of the house where it will be safe from freezing.

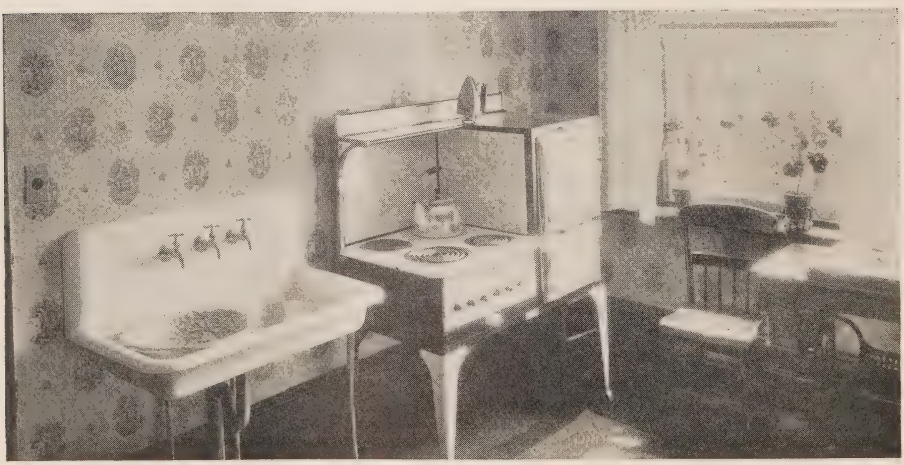
Reducing Cost

Mr. Averbeck and the hired man dug the trenches for the pipes, 64 feet of trench from the well to the house, and 75 feet from the well to the barn. It took them four days, for they had to dig through heavy clay soil. Mr. Averbeck estimates that their labor was worth four dollars a day, so if he had paid for the digging it would have cost him thirty-two dollars.

The power company furnished them the complete system, with pump, motor, pressure tank, gauges and automatic control, and the piping to the kitchen sink, to two hose connections outside, and to the tank in the barn. They installed it for him, and the entire cost was $200.00.

"We had always had to carry every bit of water to the house, and you can guess we were tired of that," said Mrs. Averbeck. "We had wanted a water system for a long time, but we did not know how much one would cost, and we didn't want to get into something where the cost was going to be more than we wanted to pay. Buying a water system this way, we knew just what we were getting and just how much it was going to cost."

The Averbecks have a cousin who is an engineer. He came out and added a hot water tank to their water system. He put the heating coil in the furnace and did the necessary piping. If this had been done at ordinary prices for labor and material, he estimates that it would have cost fifty dollars more.



The water service to the kitchen sink in the home on a farm in the Woodbridge R.P.D. This service includes cold hard water, cold and hot soft water. In this same home on the second floor is a fully equipped bathroom where the three services are also available.

Hose Connections Useful

"We've had a lot of good from those outside hose connections this summer," said Mr. Averbeck. "One of them is for the lawn, and the other for washing the car."

"Yes, we had plenty of chance to water the lawn this summer," laughed Mrs. Averbeck. "We used gallons and gallons of sprinkling. I kept our celery patch going with it too. We wouldn't have had any celery now if I hadn't sprinkled it."

"I used that hose a lot when we were filling silo," went on Mr. Averbeck. "The corn was awfully dry, and I kept the silage wet when we were putting it in, and then I put some more water in afterwards. The silage is keeping fine. I've had less spoil than I ever had before."

"You are going to take a lot of comfort in having plenty of hot water, too," I suggested.

"Yes," he agreed. "Of course, my wife will enjoy it in the house for cleaning and washing clothes, but we use a lot for our poultry and hogs, too, in the winter. They need warm drinking water and hot mashes, you know."

After we left the Averbecks, we went back to Kinkers' Korners and turned west to the Herman Totz farm.

Mr. Totz had put in two water systems this summer, one a deep-well system for hard water, the other a shallow well outfit for the cistern. Both are completely automatic. He built a new cistern and dug the trenches from the well to the house, and from the well to the barn. He also furnished the kitchen sink and its faucets for hot and cold soft water and drinking water.

His labor on the job took several days, but he did it when haying was over, and farm demands had slackened a little.

The company installed the two water systems, each with its own pressure tank, laid the pipes, put the coil in the furnace for the hot water, furnished the extra tank for it,—and charged him $325.00.

At a third place a shallow well system with a capacity of 420 gallons an hour, was put in right under the kitchen sink at a cost of $141.25 complete.

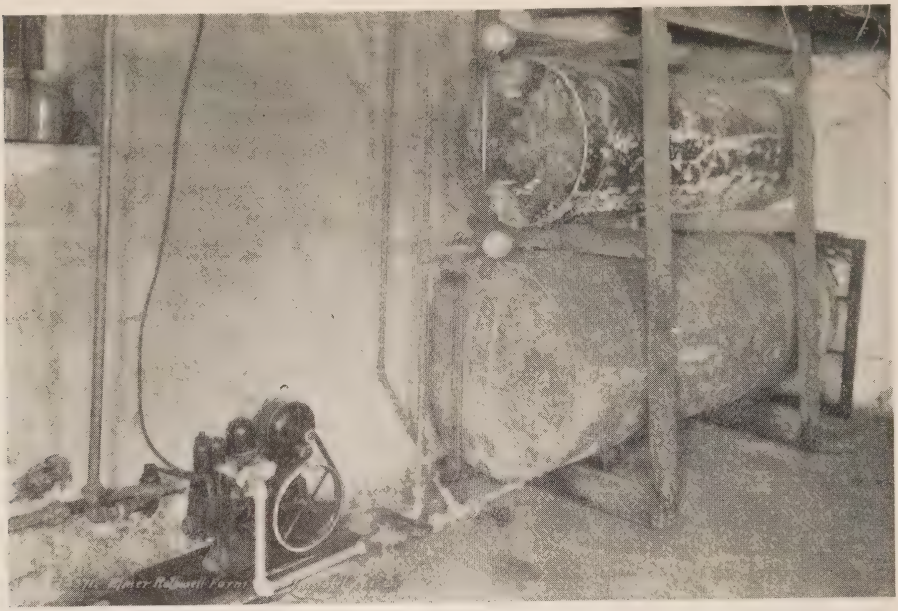
Once the question of the price of a water system is disposed of, the question of its operation bobs up. While we were talking with Mrs. Averbeck, she had said :

"We thought a water system would be quite expensive to run, but it isn't. We can't see any increase in our bill to lay to that."

Operating Costs

The operation costs have been determined for us by several experiment stations. Engineers have metered many water systems on many different farms and discovered how much electric current it takes to run them.

Down in Kansas three farm families used an average of 11 kilowatt hours a month to pump water for the house, for watering the lawn and garden. Two of these families had four people in the family, the other six. The water had to be lifted from 95 to 114 feet. They used just over 38 gallons of water per person per day on their farms, and electric current carried it



Dual automatic pumping service supplying hard and soft water on a farm in the Innisfil R.P.D. south of Barrie. One automatic pump with a two-way valve on each side of it, takes care of both these services, the hard water being drawn from a well close to the house, and the soft water from a cistern under the kitchen.

Systems that automatically supply either hard or soft water by the opening by the proper tap, are also available.

for them at less than two kilowatt hours for every 1,000 gallons.

Test Results

A two-year test in Iowa is reported in the bulletin "Electric Service for the Iowa Farm," published by the Engineering Experiment station at Ames, Iowa. These figures, taken from a table in that report, show an even lower average.

In a Nebraska bulletin on "Water and Sewage Disposal Systems for Farms," Ivan Woods writes:

"Since the project of rural electrification was started in 1926, accurate costs of operation, amounts of water used in the house, and data on depths of wells from which water was pumped have been kept. On one farm the well is 65 feet deep. The maximum pressure in the pneumatic tank is set at 48 pounds. The electrically operated water system has required 1 kilowatt hour of electrical energy for every 400 gallons of water. This farmer pays 5 cents per kilowatt hour for electricity for pump operation. At this rate the power cost is 12½ cents per 1,000 gallons pumped. On another farm a well is 35 feet deep, maximum pressure in the tank is 50 pounds, and 670 gallons of water per kilowatt hour are pumped. At 5 cents per kilowatt hour this cost is about 7.4 cents per 1,000 gallons

pumped. A shallow well system pumping from a cistern and against a maximum of 50 pounds pressure in a pneumatic tank is pumping 940 gallons per kilowatt hour of electrical energy used.

"On all of these sytems water meters as well as electric meters have been used and read once a month. Where modern toilet, bath and kitchen plumbing are installed, the family of six is using slightly more than 100 gallons per day."

In town everybody connects to the water mains and uses the city water as a matter of course. City water is so cheap that no one is willing to do without it. Yet the rates are almost always more than 10 cents per 1,000 gallons, and under many conditions the electric current to pump water on the farm actually costs less than water drawn from the city supply.

What is the market price of water on your farm?—*Electricity on the Farm.*

The 5 cents per kilowatt-hour referred to in working out a cost of 7.4 cents per thousand gallons when pumping from a well 35 feet deep, results in a higher cost than would obtain in rural service in Ontario. Under these same conditions, the cost for pumping water at the rates in force, which average nearer 3 cents than 5 cents, would be approximately 4.5 cents per thousand gallons.

—*Editor.*

The old wooden pump still seen in use on many farms in the Province of Ontario. The one on this farm in Waterloo County has been adapted to the modern service of electric drive.

Electric Shock: Interpretation of Field Notes

By Wills Maclachlan, Employees Relations Dept., H.E.P.C. of Ont.

INFORMATION in connection with cases of electric shock in Canada and the United States has been collected over a period of the last twelve years. In 1928, the interpretation of the information then available, together with details of the report forms and other information pertaining to the Insull Medal and the Canadian Electrical Association Resuscitation Medal, was published in *This Journal** in a report prepared for the Engineering Committee of the Conference on Electric Shock. The present report is based on information available in the medal report files and on information, particularly regarding fatal cases of electric shock, obtained from various large utility and electrical manufacturing companies. The thanks of the author are extended to the National Electric Light Association and the Canadian Electrical Association for their courtesy in allowing information to be taken from their files, and to the executives and field forces of the utility and electrical manufacturing companies for their co-operation in reporting cases.

Reports of approximately 700 cases of electric injuries have been obtained. These have been carefully examined, and 479 cases have been selected which meet the following requirements :

1. A person receives an electric shock, becomes unconscious, and stops breathing. Resuscitation is started, and the patient breathes and lives. 323 cases.

2. A person receives an electric shock, becomes unconscious, and stops breathing. Resuscitation is started but fails to restore breathing, and the patient dies. 156 cases.

The rejected cases come in such groups as : broken neck, extensive burns leading to death, patient did not cease breathing, no resusciation performed—the patient dying, insufficient information, and so on. It was felt that by limiting the present investigation to very definite types of cases, those lending themselves to comparison, some definite trends might be disclosed which would confirm laboratory work on animals and open up new leads for future laboratory work.

In many cases of electric shock which occur in the field, the victim becomes unconscious and stops breathing. Electrical workers, generally, have been trained in the prone pressure method of resuscitation, and have been instructed to apply it promptly and to continue it until there are specific evidences of death or until the patient breathes naturally. In cases of apparently similar

* Recent Experience of the Public Utilities of the United States and Canada in The Use of The Schafer Prone Pressure Method of Resuscitation in Cases of Electric Shock. The Journal of Industrial Hygiene, 1928, 10, 117.

types of shock, it has been found possible to resuscitate one victim and impossible to resuscitate another. This condition has led to a very extensive investigation into the whole subject of electric shock; and much animal experimentation has resulted in more exact knowledge of the effect of the passage of electric current through a living animal. However, careful and exact information from field cases must be obtained and interpreted in the light of the results of laboratory work before deductions from experimentation and investigation can be of real value in an actual case of electric shock in man.

It is a well-known and acknowledged fact that in some cases of electric shock, even at high potentials and resulting in severe burns, the victim does not cease breathing. These cases, however, are exceptions and will be dealt with only by reference.

Analysis of Data

No attempt has been made to compare the efficacy of resuscitation in all cases of electric shock, but a particular group of cases has been selected which represents the great majority of cases that occur. In various groupings, such as by month, by hour, by potential, and so on, the percentage of successful cases in the entire group has been determined. By comparing the various percentages for, say, the different months of the year, an interpretation may be made as to the variation in severity of shock, if any, between the different months.

TABLE I.
RECORD OF ACCIDENTS BY YEAR

Year	Total Cases	Successful Cases
1918	2	..
1919	2	..
1920	3	2
1921	6	1
1922	17	12
1923	20	15
1924	33	28
1925	52	44
1926	73	56
1927	102	65
1928	98	61
1929	71	39
Total.	479	323

Comparison by Years

Table I shows the year in which the accident occurred. As the medal reports started in 1922 and the personal canvass for reports of fatal cases started in 1927, naturally more information is available for the recent years. There is also a time lag in the reporting of cases; hence complete records of all cases for 1929 are not yet available.

Comparison by Months

Table 2 shows for each month the total number of cases and the number and percentage of successful cases. As most of the victims of the shocks were public utility employees working outside, one would expect more accidents in the summer months; it will be seen from the table, however, that the percentage of successful cases seems to fall, as the year progresses, until late summer when it rises again. This is more clearly shown in *Fig. 1.* The third degree curve shows the

TABLE 2.—RECORD OF ACCIDENTS BY MONTH

MONTH	TOTAL CASES	SUCCESSFUL CASES		VALUES GRADUATED BY THE CURVE $y = 62.521 - 3.169 + 0.728\ x^2 + 0.165\ x^3$	DESCENDING TREND LINE $y = 63.471 - 2.412\ x$	ASCENDING TREND LINE $y = 51.332 + 5.925\ x.$
		No.	Per Cent.			
Jan.	16	11	69	72.1	77.9	
Feb.	22	19	86	75.9	75.5	
March	26	17	65	75.3	73.1	
April	28	22	79	74.1	70.7	
May	53	36	68	70.5	68.3	
June	69	51	74	66.3	65.9	
July	68	37	54	62.5	63.5	
Aug.	67	43	64	60.2	61.1	
Sept.	45	26	58	60.4		63.2
Oct.	38	24	63	64.0		69.1
Nov.	30	23	77	72.1		75.0
Dec.	17	14	82	85.5		81.0
Total	479	323	67	...	...	...

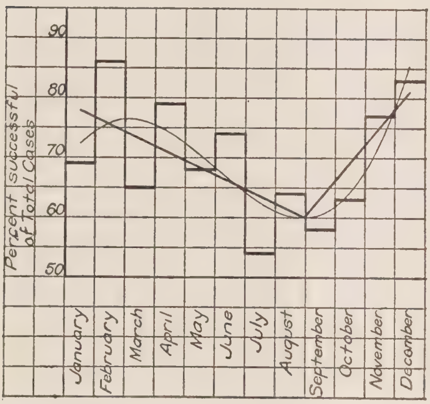


Fig. 1.—Comparison of successful resuscitation cases. The block curve gives the percentage of successful cases by months; the third degree curve calculated from these values, shows the maximum on March 1 and the minimum on September 1; the two straight lines show the trend. (Although the exactness of mathematical precision was carried out in the development of these curves and lines, the practical value is only to show a trend.)

maximum of successful cases on March 1 and the minimum on September 1. An interpretation of this last fact might be that the employees were then wearing less clothing, and owing to hot weather were perspiring. Under these circumstances the electric contact would be better, or, in other words, the resistance at the point of contact between patient and conductor would be less. As the contact resistance is a large part of the total resistance of the victim, the total resistance is greatly reduced. For an equal potential this will result in a greater current passing through the victim. Laboratory results show that with increased current the shock is more severe, all other conditions being equal.

Comparison by Hours

In Table 3 is given the hour of the day in which the accident occurred. It will be noted that for the normal working day—*i.e.*, from 8 a.m. to 5 p.m.—the percentage of successful cases increases as the day progresses, with the break for noon hour, and reaches a maximum between 1 p.m. and 2 p.m., and then falls during the afternoon. *Fig. 2* shows the percentage of successful cases by hours. The working day was chosen because the work and supervision are the same during these hours. At other times varying conditions prevail. A comparison of the percentage successful between 5 p.m. and 6 p.m. with that between 2 p.m. and 3 p.m. would obviously be incorrect because, to mention only one variable, different shifts would probably be working. It will be seen that the curve for the morning is the reverse of the curve for the afternoon. The falling of the

TABLE 3.

RECORD OF ACCIDENTS BY HOUR.

Hour	Total Cases	Successful Cases	
		No.	Per Cent.
5-6 a.m.	1	..	..
6-7 a.m.	1	1	100
7-8 a.m.	13	10	77
8-9 a.m.	25	14	56
9-10 a.m.	53	30	57
10-11 a.m.	49	34	69
11-12 m.	60	44	73
12-1 p.m.	12	7	58
1-2 p.m.	34	26	77
2-3 p.m.	61	44	72
3-4 p.m.	68	43	63
4-5 p.m.	36	23	64
5-6 p.m.	25	19	76
6-7 p.m.	12	8	67
7-8 p.m.	10	6	60
8-9 p.m.	7	6	86
9-10 p.m.	4	3	75
No Time	8	5	63
Total...	479	323	67

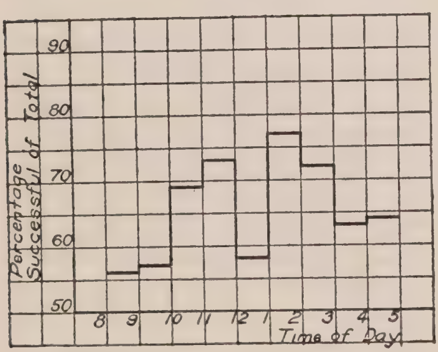


Fig. 2.—Comparison of successful resuscitation cases by hours during the working day.

percentage of successful cases during the afternoon may be interpreted as the effect of fatigue on the severity of the shock or on the success of resuscitation. No such interpretation would, however, apply to the morning. It would seem that laboratory work to clear up this matter is indicated.

Comparison by Potential of Circuit

In Table 4 is shown the potential of the circuit involved in the accidents, and the percentage of successful cases at each potential. The divisions selected shows: (1) the potential of the circuits commonly used in houses and manufacturing firms; (2) the primary distribution voltage in towns and cities; (3) transmission voltages of a secondary character; and (4) voltage for long distance transmission. The first is handled by laymen as well as by trained electrical workers, and the contact with it is liable to be solid and hence of low resistance. The second

TABLE 4.

RECORD OF ACCIDENTS BY POTENTIAL OF CIRCUIT INVOLVED

Voltage	Total Cases	Successful Cases	
		No.	Per Cent.
0- 749....	65	41	63
750- 4,999....	212	138	65
5,000-39,999....	167	116	69
40,000 and over..	26	23	88
Lightning.......	2	2	100
Induced current .	4	2	50
No voltage given.	3	1	33
Total........	479	323	67

is usually handled by trained electrical workers using insulating rubber gloves and other protection, and the contact is accidental and poor. In the last two cases, it is handled only by trained electrical workers with special appliances, and contacts are accidental; frequently there is no direct contact between conductor and victim but contact through an arc.

It will be seen that as the potential rises, the percentage of successful cases also rises. At least one cause for this is the probability that the contact in the higher potentials is poor and of brief duration.

Comparison by Duration of Contact

In field cases, it is impossible to learn the exact duration of the contact. It is possible, however, to get a gauge of this. In the report form the question was asked; "How was victim cleared from the circuit?" Many reported, "Fell Clear;" others, "Pulled clear"; and still others, "Switch was opened." In the case of a victim falling clear, the duration is very short; if the victim has to be pulled clear or if the switch has to be opened, there is a contact of appreciable time.

Table 5 shows the percentage of successful cases in which the victim "fell clear"; all other cases are grouped under "pulled clear". It is noticeable that a higher percentage of successful cases is in the group "fell clear". This would tend to suggest that the duration of contact is a gauge of the severity of the shock and would support laboratory work along this line. This is very noticeable in those cases with potentials of 0 to

TABLE 5.

RECORD OF ACCIDENTS BY METHOD OF CLEARING PATIENT FROM CIRCUIT

Method of Clearing	Total Cases	Successful Cases No.	Successful Cases Per Cent.
Fell Clear....	282	198	70
Pulled Clear*	197	125	63
Total.....	479	323	67

* All those cleared by other means than falling clear.

750 volts, and in those with potentials of 40,000 volts and over; in the first instance, the contact being usually good and in the second, the current passing through the victim being high.

Comparison by Time Between Shock and Application of Resuscitation

It is difficult, if not impossible, to obtain the exact time that elapses between the shock and the first application of resuscitation. This is primarily due to the fact that those present are excited, and their first thoughts are for the relief of the victim. An analysis has, however, placed the cases in two groups; those in which a very short time elapsed between the shock and the application of resuscitation, three minutes or less; and those in which there was a longer lapse of time, four minutes or more.

In Table 6 is shown the percentage of successful cases in these two groups.

TABLE 6.

RECORD OF ACCIDENTS BY TIME ELAPSED BETWEEN ACCIDENT AND COMMENCEMENT OF RESUSCITATION

Minutes Elapsed	Total Cases	Successful Cases	
		No.	Per Cent.
0-3	361	254	70
4 and over	118	69	58
Total	479	323	67

From this it is quite apparent that more success is obtained by the prompt application of resuscitation. This is noticeable in all groupings both as to voltage and as to duration of contact. Laboratory work on animals also points to this conclusion.

Path of the Current

A careful examination of the cases was made with a view to finding whether any information was available as to the path of the current in shock cases. Since most of the cases were those of workmen, they would be liable to contact from hands or arms, and since in many instances they were standing on ground or with their feet in contact with ground wires, the path of the current would traverse the trunk. On examination, it was found that the path of current was from head to feet; hands to feet; arms to legs; or hand to hand. In each case the path was practically the same. No particular difference in percentage of successful cases for the various points of contact could be obtained. Owing to the very routine of the work carried out by the men, the path of current is likely to be the same.

Individual Cases

In carrying out the analysis, many interesting individual cases were noted. One is particularly impressed by the careful and extensive training of public utility employees in the prone pressure method of resuscitation, first put forward by Sir Edward Sharpey Schafer, and also by the promptness with which it is applied. In over 75 per cent. of the cases under consideration, resuscitation was commenced within three minutes of the accident. When one considers that during this time the victim had to be cleared from the pole or other structure and be placed in position, the results of training and instruction are quite easily seen.

In some of the cases under review, the injuries after the effect of shock had passed off, were very slight. In others, the injuries were severe; such as amputation of leg and arm on account of burns, excision of the entire top of the skull on account of necrosed bone, and development of cataract. In no case of resuscitation was there any permanent paralysis unless gross destruction of tissue had taken place; and no evidence of paralysis of the lower limbs was indicated in the fatal cases.

It is seldom possible to obtain a clear-cut statement from a victim of electric shock as to sensations immediately after the accident. The following statement from a line foreman is, however, the clearest that has come to the author's attention. This case was not considered in the above analysis, for resuscitation was neither indicated nor performed.

"In reference to my accident of February 9, 1929, when accidentally coming in contact with 22,000 volt line at front of substation: I had a ladder placed against the substation wall which reached a height of approximately forty feet, and upon climbing to the top of the ladder I grasped an anchor bolt that was secured in the cement wall with my left hand (I was wearing a pair of leather gloves), and I passed my right hand over to the line upon which I had thought dead and was intending to remove a tap.

"When the back of my right hand came to within a half or three-quarters of an inch on the conductor, six or seven tiny blue waves, thread-like streaks of flame, suddenly leaped to my second knuckle of ring finger on right hand. Immediately my head seemed to enlarge and burst with pain, and I heard the most teriffic noises in my head and ears as if I were inside a most powerful generator, and seemed to feel the pulsations with its powerful hum; while at the same time, my body, legs, and feet seemed to shrink to nothing, until I felt I could stand on a ten cent piece. Both hands, at the same time, had a stinging, burning sensation. I can't begin to tell you how many seconds this lasted, but it seemed to me a terribly long time.

"My senses were partially numb but I was conscious and felt that I was in the grip of some powerful monster. My efforts to move my right hand or arm were futile against its magnetic strength. Even my eyes were fixed in a stare as I watched those hairlike streaks pouring into my finger, and at no time were they any larger than half an inch in diameter.

"I think I owe my life to getting clear of it with my left hand which was holding the anchor bolt, and I found it one of the hardest tests of concentration of will power in trying to use the muscles of my left hand. Even my sense of feeling was gone, and I could not shift my eyes from staring at those blue streaks.

"I failed in my first attempt to use my muscles in my left hand ; in fact I felt like a wooden man. I had no power of any muscles, and then some superhuman will power seemed to concentrate on my left hand, and I had the sensation of feeling my finger slowly dragging off that bolt; and pain increased as I was losing contact. It was my first glimpse of my left hand as I saw it leave the wall. I had no sense of balance left nor any fear that I might fall, and was glad to get away from that awful torture. It is torture and if electrocution has that feeling, then God help the criminals. Anyway, I felt that I had won out, when I took a left turn and plunged toward the ground. The snow below looked very faint, and I felt as if I were in semi-darkness as I could see the foot of the red ladder below, and as I gained speed it grew darker. With my ears ringing, my head swimming, and my brain trying to fight those terrific noises, I tried to keep my senses or rather partial senses. It seemed so easy to pass out, and then as I was about halfway down the noise increased; and then, with a bang as if my head had exploded, I was in inky darkness.

"Not until then, did I feel that I

was done for, but the next instant my eyes flew open, and I felt myself being propelled upward. I was looking at the white snow, and my senses were partially awake, and I realized that I had fallen flat on my stomach; my arms and legs were fully extended, and as I met the snow the second time my head cleared of all those hellish sounds; perhaps I had bounced a foot, as there were about nine inches of snow.

"My senses then cleared immediately; my first act was to spit out a mouthful of snow, rub the snow out of my eyes, put my hands forward, and stand up. I didn't stop to examine my hands, although they were stinging terribly, and I knew they were burned. I suddenly thought of getting oil to put on them and started round the building to go upstairs, such an act as I was always taught not to allow anyone to do, but it did not occur to me then. I had my mind fixed on getting to that oil. I tucked my hands under my armpits and was on my way when I was met by my fellow worker who stepped in front of me and asked me what was the matter. For some unknown reason I felt very antagonistic towards him, felt as if he were going to try and stop me; so simply said, 'I made a mistake,' put my shoulder against him and started on again.

"I took a few steps more, when my workman confronted me again with, 'Where are you going?' I said, 'Get out of my way, get my cap,' and went on up the twelve or fourteen steps to the main floor. My heart was pounding, but I felt pretty fair, and on the landing at the top I met my brother. I asked him to get the oil. Didn't offer any explanation, but he seemed to know by my face that I needed it. I then sat down on a chair in the operator's office as I felt all in and began to battle with my senses again. It was useless and I didn't have enough sense to ask for help—just floated away. My next sensation was of being dragged along the floor, as they were preparing to apply respiration, but I managed to say I didn't need any help.

"I was kept lying down and they bathed my hands in oil and it did relieve the pain at once. The doctor examined me then, and they proceeded to remove me to an ambulance. While in the ambulance I had a great fight to keep from passing out. It seemed so easy to float away, but I kept bumping my head on the stretcher, and each bump seemed to clear my head. When I arrived at the hospital I was given a drink of whiskey, and my attention was again on my burns which consisted of one finger on my right hand burned to the bone and two holes in the muscle of my left thumb where I had made a partial ground connection."

"P.S.—Forgot to mention that after coming into the substation I was very cold, even though I had a lot of extra clothing and blankets, and it took about two hours to get warm."

Any number of interesting cases of resuscitation might be described in order to bring out various facts. That it has been possible, by hours of continuous effort, to resuscitate an apparently lifeless victim of electric shock has been referred to by many authors; and at least one explanation

has been put forward as a result of laboratory work. There follows a brief description of the longest case of resuscitation after electric shock that has come to the author's attention.

On May 22, 1927, at 2 p.m. a young lineman in a town in Ontario received a shock of 22,000 volts from head to hands and legs. He fell back into his life belt, unconscious and not breathing. He was lowered to the ground by fellow employees and resuscitation commenced at once. A doctor was called, and the patient was removed to the hospital in an ambulance, resuscitation being carried out during transportation. Boards were placed over a hospital bed and resuscitation continued. At 2.40 p.m. long distance telephone communication between the attending doctor and consultant in Toronto was established and maintained as required. Sufficient trained employees remained in the hospital in order to relieve each other and thus carry out resuscitation efficiently without fatigue. Attempts were made from time to time to stop resuscitation, but the patient would not breathe voluntarily. Between 7 and 8 p.m. the patient became cyanosed, but this cleared up on change of operators. At 10 p.m. the patient breathed of his own volition, and manual resuscitation was discontinued. Employees were left in the hospital during the night to apply resuscitation if necessary. The patient stopped breathing once, but recommenced before resuscitation could be applied. By continued application of efficient prone pressure resuscitation, success was reached after eight hours' effort.

Conclusions

From a consideration of the cases under review, the following conclusions may be reached :

1. The severity of the shock increases or the success of resuscitation decreases as the year progresses until late summer when the severity of shock decreases or the success of resuscitation increases.
2. The severity of the shock decreases or the success of resuscitation increases as the day progresses (with a break for noon hour), reaching a peak at 1 to 2 p.m. when the severity of shock increases or the success of resuscitation decreases.
3. The severity of the shock decreases or the success of resuscitation increases as the potential of the circuit involved increases.
4. The severity of the shock is less or the success of resuscitation is more, in cases where the victim fell clear of contact than in those in which the victim was cleared by other means.
5. The success of resuscitation is more in cases where the application of resuscitation is carried out in three minutes or less after the shock, than in those in which it is carried out in four minutes or more.
6. No information is available as to the severity of the shock or the success of resuscitation for various paths of current through the victim, since the nature of the work makes the paths of curren the same.

Interpretation of these conclusions leads one to believe :

1. That the severity of the shock is increased by the reduction of contact resistance.

2. That laboratory work is indicated to explain the apparent difference of severity of shock between different hours of the day.

3. That the severity of the shock is increased by the increase in the duration of contact.

4. That the success of resuscitation is increased by the prompt application of resuscitation.

5. That public utility employees have been well trained in the prone pressure method of resuscitation.

6. That success in resuscitation from electric shock may result after many hours' work on an apparently lifeless victim.

The author wishes to express his thanks to Miss M. B. Woods, Secretary of the Insull Medal Awards Subcommittee, for the careful preparation of information from the files; to Mr. Hugh Wolfenden, Consulting Actuary, for checking the tables and preparing the curves; and to many who made possible the preparation of the paper.

—*The Journal of Industrial Hygiene.*

Spillway falls, Alexander power development from the opposite shore. The falls are 60 ft. high and 525 ft. long at the crest. The picture shows the full flow of the river discharging over the dam.

Alexander power development power house and spillway.

Main Street, Dundas, Ont., looking west. The upper view shows the street before and the lower after the street lighting had been remodelled and the distribution placed at the rear of the properties.

Main Street, Dundas, Ont., looking east, with corresponding views as shown the opposite page.

"The R-101"

" . . . grieved beyond words at the loss of so many splendid men whose sacrifice has been added to that glorious list of Englishmen who, on unchartered seas and unexplored lands, have gone into the unknown as pioneers and pathfinders and have met death. . . . "

—*Premier Macdonald.*

IN the September issue of *The Bulletin*, we recorded a few facts of the successful flight of the airship R-100 to Canada. Just those few short weeks ago, travel by airship seemed to be almost an assured thing, awaiting only the building of more airships for its establishment on a commercial basis.

Not so easily, however, is man's mastery of the air to be attained. On Sunday, October 5th, less than eight weeks after the R-100 had safely completed her return journey from Canada, came news of the tragic disaster to her sister ship, the R-101, with the total loss of forty-eight lives, among them being those of some of the most prominent of England's aeronautical men, viz:—Lord Thomson, British Air Minister; Sir Sefton Brancker, Director of Civil Aviation; Lieut. H. C. Irwin, In command of the R–101 ; Wing-Commander R. B. B. Colmore, Director of Airship Development; Major G. H. Scott and Col. V. C. Richmond, Assistant Directors of Airship Development.

Colmore and Scott were on the R-100 on her voyage to and from Canada; Richmond was the designer of the R-101.

After leaving England in the evening, only a few hours before the disaster, on a journey to Karachi, India, the R-101 encountered a violent rain storm in the north of France during which, at 2 a.m., she lost altitude, for some as yet unexplained reason, and, in the mist and darkness, crashed into the side of a hill near the village of Beauvais in north-western France. Almost immediately, the great ship became a veritable furnace and soon practically nothing was left of her except a broken and twisted skeleton frame. Eight of the persons on board managed to drop to earth but the other forty-six were trapped with no way of escape; of the eight who survived the accident, two died in hospital later.

The bodies of the unfortunate victims of this great wreck were brought back to England on a warship and interred in a single grave at Cardington.

The intense interest taken in this attempted flight is shown by the fact that the Air Ministry in England received messages of sympathy from all over the world, and indications of that sympathy were evident in all newspapers.

It is generally recognized that the use of hydrogen, of which the great balloonets of the airship contained some 5,500,000 cubic feet, was responsible for the large number of deaths and for the fact that the ship was totally destroyed. Helium gas would, of course, have provided much greater safety for both the personnel

View of the wreckage of the "R-101" looking aft. — The Engineer.

and the ship itself but nowhere in the world is it commercially possible at present to obtain helium in sufficient quantity to serve the needs of airships, except in the United States. That country, however, knowing this fact, prohibits the exportation of helium; it was therefore inspiring to note that, as soon as the loss of the R-101 became known, several prominent naval men in the United States immediately advocated that the export of helium to England and Germany be permitted in order to avoid, as far as possible, any recurrence of so terrible a tragedy. It is to be hoped, however, that, whatever the United States may do, efforts will be made to find commercial quantities of helium somewhere within the British Empire, and that these will be successful.

The Air Ministry is making a full investigation into this most regrettable accident. It has been reported that parts of the airship were found five miles to the rear of the spot where the ship came to earth; this would indicate that the structure had been unable to withstand the fierce storm which was raging at the time; again, at least one expert has declared that he did not consider the ship to be airworthy, but the investigation may reveal the real cause of failure.

Ages ago, destruction, such as that which has befallen the R-101 and her passengers, would have been attributed to the wrath of the gods; more recently, in the Middle Ages, the devil would have had to bear his share of the blame for instigating human beings to tempt the Creator; in both cases, probably, further work would have been permanently abandoned. To-day, we try to ascertain the real physical cause with a view to designing a new and possibly greater

ship free of the defects of that which was lost.

Only thus, with undaunted spirit, undimmed imagination, and unabated energy, does man conquer the material world around him and approach more nearly to that high estate of dominion over all created things to which he is the prophetic heir.

—*A.S.L.B. and F.K.D.*

19th Annual Safety Congress

The Congress of the National Safety Council was this year held in Pittsburg, and was attended by various representatives of the Hydro-Electric Power Commission. The slogan of Pittsburg was "Keep Alive", and to a great extent sums up the present attitude of those carrying on accident prevention work. In short, the prevention of accidents is a personal matter. It is possible to minimize the hazard by efficient design and guarding, by the development of safe practices which are effectively carried out and by education and training of men. The whole matter, however, comes back to the personal equation and the responsibility of each man to protect himself and his fellow workers.

One is continually impressed by the large numbers who attend the Congress and there is a growing number of Operating executives who are attending the Congress and taking a very active part in its proceedings both in the presentation of papers and in the discussions, showing clearly that the prevention of accidents is recognized as part of the general operation of any property.

This year the exhibit carried out by manufacturers was more extensive and covered a greater variety of types of equipment than had ever been presented before. Numerous types of safety equipment were shown, the details of a number of these being particularly noted by representatives from the Commission.

One has but to attend one of these Safety Congresses to realize the importance of this work, whose great object is to "Keep Alive" men and women for service to their families and society in general.

Resuscitation at Kitchener

On November 12th, about 7 p.m., in the evening, M. Anderson, an employee of the Preston Rural Power District, went into the General Battery Service Station in Kitchener to have the battery of his car attended to, and while waiting to have this work completed, Walter Benninger, an employee of the Service Station got in contact with approximately 100 volts d-c. receiving an electrical shock, rendering him unconscious and he stopped breathing. He was cleared by another employee of the Service Station, and Mr. Anderson immediately put him in position and started prone pressure resuscitation. After a few minutes the man was partially breathing and in about fifteen minutes he was breathing and semi-conscious. A doctor was then present and took charge of the patient.

By knowing what to do and having the presence of mind to immediately put his knowledge into action, there is no doubt that Mr. Anderson was

instrumental in saving a life. The knowledge of this fact will remain with him always.

Are we all ready in an emergency to put our knowledge and training into effect?

The following letter has been received:—

"I would like to take this opportunity to express my appreciation of the prompt action of one of your men, Mr. Anderson, in applying artificial respiration on a patient who had received an electrical shock and rendered unconscious. This knowledge of first-aid and prompt application of it may have meant the difference between life and death for this man. In my opinion, this work is of the greatest importance and cannot be too highly stressed and commended. (Sgd.) W. G. MACDONALD, M.B."

An Insulated River

The following is an extract from a letter received by Mr. J. H. C. Brooking, from Mr. E. Hitchcock, of the Municipal Electricity Department, Christchurch, N.Z.

"The verses 'Cleanliness versus Insulation' in the *Electrical Engineers' Ballad Book* remind me of an interesting comparable experience which happened in this city some years ago. The city is situated on the Canterbury Plains, most of which are extensive shingle beds. Our reticulation is an earthed-neutral system. In some localities it is exceedingly difficult to secure a good earth. In the outskirts of the city, some of the houses took their water supply from a race. The neutral of the electrical installation was earthed to the water pipe. A fault developed, and the pipe was made alive right back to the race. The ground was of such high resistance that the race itself became alive, and the water virtually an insulated conductor. Someone noticed horses approaching the race lower down, to drink. Immediately their lips touched the water, they threw up their heads and galloped. Someone investigated matters and received a shock. The supply engineer was advised that the race was 'alive'. He scorned the idea but went out to investigate. He stood on the edge and threw in the end of a piece of fence wire, and was knocked down. Investigation traced the trouble back to the fault in the house. The water was running on clean pebbly shingle. The man and the horse were standing on a covering of turf. The difference provided conditions for the shock." — *The Electrical Review.*

HYDRO NEWS ITEMS

Eastern System

An extension is being built from Harrowsmith to the villages of Hartington and Verona in Kingston Rural Power District.

* * * *

Georgian Bay System

The Barrie Distributing Station is the largest station on the southern end of the Georgian Bay System. The station supplies the Town of Barrie and considerable rural load to adjacent points in the vicinity. The load has been gradually increasing and last year considerably overloaded the two installed Scott connected banks of 1,400 kv-a. total capacity. This station was one of the few two phase stations on the system, and as the municipal underground feeders have been equipped for three phase it was decided to install a new bank of transformers to supply three phase 4,000 volt power.

Three 1,000 kv-a. single phase transformers were accordingly purchased and a steel structure designed and erected just outside the distributing station building. This structure was designed for 38 kv. so that two banks of three 1,500 kv-a. single phase transformers with two line breakers and a line tie air break switch could be installed. However, for the present only one-half of this structure has been erected and one bank of three 1,000 kv-a. single phase transformers with 38 kv. switching equipment installed with line breaker omitted. This new bank is at present operating at 22 kv., being supplied direct from the 22kv. bus supplying the two Scott connected banks in the building.

The 4,000 volt, three phase, secondary from this new bank is carried in to the building and connected to the existing bus of the Municipal Commission's structure through a set of disconnecting switches. Three of the heaviest loaded single phase feeders were accordingly connected so that they could be fed from this new 4,000 volt supply, or from the 2,300 volt, two phase supply, through the Municipal Commission's two pole double throw switches. With this arrangement, approximately 1,100 horse power can be carried by the new bank until such time as the Municipal Commission have completed the changing of their whole system over to three phase, This change is expected to be accomplished during the year of 1931, and the Scott connected transformers will then be removed.

The three phase load is metered by means of two graphic wattmeters, energized from current and potential transformers in the 4,000 volt secondary leads from this new bank.

* * * *

Niagara System

The Ontario Hospital located immediately north of Woodstock, in the Woodstock Rural Power District, is

erecting a number of new buildings and proposes further additions during the next year. A central heating system and sewerage disposal plant are about completed. When the proposed buildings are completed about 100 horsepower of electrical energy would be required, which will include power for an up-to-date laundry.

* * * *

The Windsor-Detroit tunnel was put into operation on November 3rd. The total load taken by the tunnel is approximately 1,600 horsepower, one-half being supplied by Windsor Hydro. Two separate, 4,000-volt feeders, one from each substation of the Windsor Hydro have been installed. Provision is made in the electrical layout so that the whole of the load of the tunnel can be carried from either the Canadian or U.S. side of the river, in case of a power failure on either side.

* * * *

The line between Wallaceburg, Port Lambton and Sombra, in Wallaceburg R.P.D., which is 14 miles in length, has been changed to 8,000/4,600 volts. A bank of 3—50 kv-a., 4,000/4,600-volt transformers was installed at Wallaceburg town limits. Twelve miles of new 8,000/4,600 volt line was also added in this district.

* * * *

Additions to the substation capacity and improvements in the layout and design of the Chatham substation are progressing favourably. A 3,000 kv-a., 26,400/4,000 volt, 3-phase transformer has been added, bringing the 4 kv. capacity of the station to 8,000 kv-a. The 3-phase 750 kv-a., 26,400/575 volt transformer, as well as the constant current street lighting panels and regulators, have been moved to a new room in the rear to allow for an emergency 4,000 volt bus, and the feeder switches of larger rupturing capacity. A tank for cooling the water from the transformers has been constructed at the rear of the substation building.

Association of Municipal Electrical Utilities

NOMINEES FOR 1931 OFFICERS

The report of the scrutineers giving the result of the Primary Ballot nominating candidates for officers of the Association of Municipal Electrical Utilities for the year 1931, shows the following results:—

(* These names to appear on the election ballot).

For the office of *President:* *J. W. Peart, *R. L. Dobbin, W. E. Reesor, H. F. Shearer and A. W. J. Stewart.

For the office of *Vice-President:* *O. M. Perry, *D. B. McColl, *J. E. Teckoe, C. T. Barnes, C. E. Schwenger, E. V. Buchanan, W. E. Reesor, H. G. Hall, H. F. Shearer, A. B. Scott, R. J. Smith, T. W. Brackinreid, W. R. Catton, E. I. Sifton, J. W. Peart, O. H. Scott, J. R. McLinden, R. L. Dobbin, A. B. Manson and W. G. Breen.

For the office of *Secretary:* *S. R. A. Clement, *B. Faichney and W. Monroe.

For the office of *Treasurer:* *R. M. Bond, *H. T. Macdonald, *D. J. McAuley, B. Faichney and P. Siebert.

For Directors from the membership

at large: *O. H. Scott, *E. V. Buchanan, *J. E. B. Phelps, *J. R. McLinden, *C. T. Barnes, *V. S. McIntyre, *R. H. Starr, W. R. Catton, R. L. Dobbin, E. I. Sifton, T. W. Brackinreid, W. E. Reesor, J. E. Teckoe, A. B. Manson, J. G. Archibald, A. B. Scott, O. M. Perry, T. R. C. Flint, A. W. J. Stewart, W. H. Childs, A. L. Farquharson, L. G. McNiece, W. Tait, E. J. Stapleton, R. S. Reynolds, C. E. Schwenger, J. J. Heeg, D. B. McColl, P. B. Yates, C. A. Walters, C. E. Brown, R. J. Smith, R. Harrison, A. C. Herrington, A. M. Bowman, T. Jepson and C. A. Denton.

For District Directors—

NIAGARA DISTRICT: *R. S. Reynolds, *A. B. Manson, J. E. Teckoe, W. R. Catton, O. M. Perry, H. G. Hall, J. W. Bayliss, H. F. Shearer, A. B. Scott, E. M. Ashworth, V. S. McIntyre, J. E. B. Phelps, R. B. Hanna, J. J. Heeg, E. V. Buchanan, P. B. Yates, S. Buckrell, T. Jepson and D. B. McColl.

GEORGIAN BAY DISTRICT: J. R. McLinden, *C. E. Brown and *E. J. Stapleton.

CENTRAL DISTRICT: C. T. Barnes, O. H. Scott, *C. A. Walters, *Geo. W. P. Every, F. C. Adsett and G. E. Chase.

EASTERN DISTRICT: *R. J. Smith and *H. S. Brown.

NORTHERN DISTRICT: *T. W. Brackinreid.

Industry's first windowless factory building, without daylight and embodying advanced ideas in working conditions, is to be constructed this winter for Simonds Saw & Steel Company of Fitchburg, Mass., by Austin Company. This $1\frac{1}{2}$ million-dollar structure will cover nearly two city blocks, enclose five acres of floor space; will have solid walls and roofs broken by neither windows nor skylights. The company will install elaborate lighting, ventilation, and noise-absorption systems.

All machines will be orange-colored to increase their visibility and decrease accidents; walls and ceilings will be blue, green and white. The lighting system will provide ultra-violet rays. The aim is to surround the workmen with ideal conditions. Company experiments indicate the new methods promise an increase in production-efficiency of as much as 35 per cent.

Hundreds of 1,000-watt lamps will provide uniform light intensity, impossible to daylight factories dependent upon weather and window cleanliness. Accoustical walls and ceilings will be employed to eliminate noise; all heavy machines will rest on cork pads insulated from the floor. Air will be changed every 10 minutes, purified, tempered to proper temperature and humidity.—*The Business Week.*

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Tenth Unit in Service at Queenston Generating Station

By F. W. Clark, Asst. Engineer, Hydraulic Dept., and G. E. Kewin, Asst. Engineer, Electrical Engineering Dept., H.E.P.C. of Ont.

WITH the placing in commercial service on July 4th, 1930, of number 10 unit at the Queenston Generating Station, the largest development of the Hydro Electric Power Commission was completed. Construction work on the power canal from Chippawa to the power house forebay, a distance of 12¾ miles, was started in May 1917, the first concrete for the power house was poured in October, 1920, and the first unit was initially turned over on December 28th, 1921, when the official opening of the power house took place.

For the installation of the tenth unit, extensions were made to the forebay, gate house and power house, the latter now being 590 feet long and 180 feet high from rock foundation to roof of high voltage switching rooms. A transformer bank is provided in the power house for each generator to step up voltages for transmission to the eleven outgoing 110 kv. lines and two 60 kv. lines.

The screen house and forebay extension required the excavation of 7,700 cubic yards of earth and rock, and the placing of 4,000 cubic yards of concrete in foundations and retaining walls. The excavation for the screen house was carried out in progressive stages starting with the section farthest removed from the existing forebay limits at that time and constructing the concrete piers for the screen house substructure a sufficient distance upstream to enable the stop-log head gates to be installed as added protection against flooding of the work. Following this, sufficient additional rock was removed to enable the completion of all remaining concrete work below the forebay water level. The remaining forebay rock excavation was removed as far as possible in the dry, leaving only a relatively small yardage for removal

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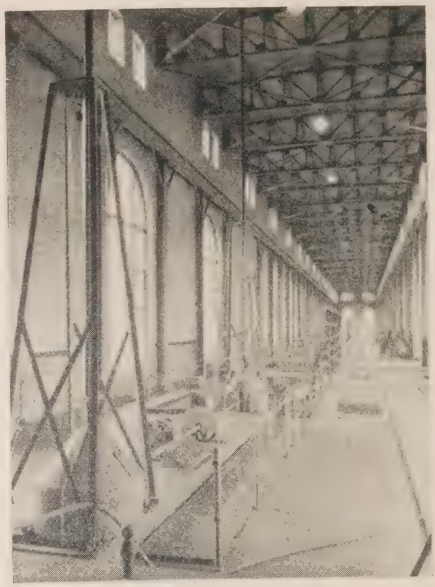
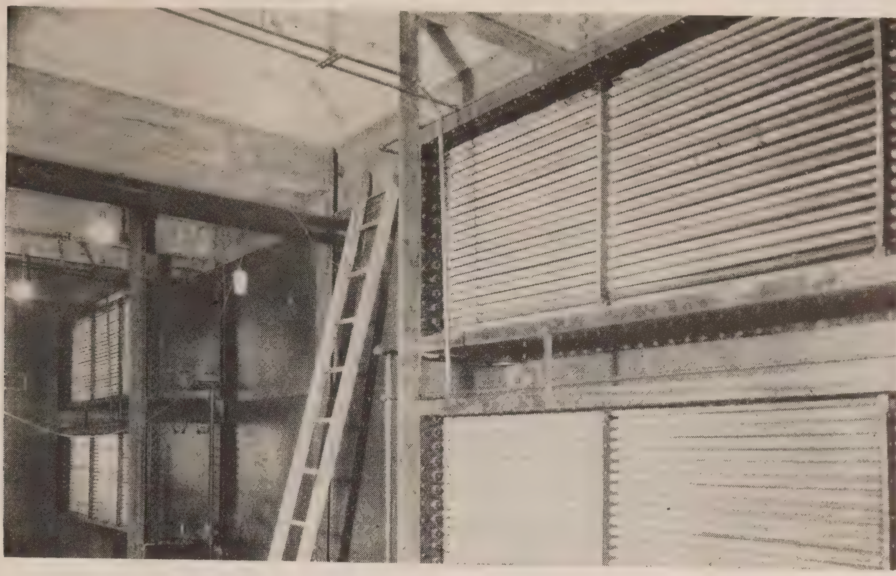


Interior view of Screen House, Queenston Generating Station

under water. By carrying out the work in this manner expensive unwatering of the site was avoided and a considerable saving in cost was thereby effected.

Downstream from the screen house substructure the penstock transition section was constructed partly in tunnel section excavated out to the face of the escarpment. From this point on a 16-foot diameter steel plate

Generator No. 10 with Control Pedestal and Governor



Air Washers of No. 10 Generator Cooling System

penstock was installed joining at the power house with a Johnson valve and supply pipe to which was connected the turbine scroll case.

The turbine is similar to those installed in units 6 to 9, having a rated capacity of 58,000 horsepower under 294 feet net head.

Cliff protection work was also carried out for some distance downstream from the power house. This involved the removal of a considerable yardage of earth and loose rock and the construction of concrete facing and retaining walls.

The table below gives the name plate rating of the ten generators and the dates on which they went into commercial service.

The complete rating of number 10 unit is 55,000 kv-a., 12 kv., 80 per cent., p.f., 25 cycle, 187.5 rev. per min., 65°C. rise, with 180 k.w. direct connected exciter.

Unit No.	Kv.-a. Rating	Kv. Rating	Frequency	Date in Service
1	45,000	12	25	Jan. 26, 1922
2	45,000	12	25	March 16, 1922
3	45,000	12	25	October 8, 1922
4	45,000	12	25	November 30, 1922
5	45,000	12	25	April 8, 1923
6	55,000	12	25	May 15, 1924
7	54,000	12	25	December 15, 1924
8	54,000	12	25	August 10, 1925
9	54,000	12	25	December 5, 1926
10	55,000	12	25	July 4, 1930

Total installed generating capacity — 497,000 kv.-a.

Queenston Generating Station, approach to Administration Building from the south

There are two noteworthy changes in the design of this unit over that of earlier units. One is in respect to the generator cooling system. The generator is encased with a metal enclosure, providing a completely enclosed ventilating system. The heated air on leaving the generator, is passed through stacks of steel tubes, through which canal water flows, and the air on being cooled is returned to the generator. The chief advantage lies in the small quantity of dirt deposited on the winding compared to that deposited when employing direct air cooling as on the other machines which also require an auxiliary fan to draw the air through the duct system.

The other change is in the governor flyball drive. The earlier machine utilized belt drive from the main turbine shaft to the flyball shaft, whereas, on this unit the flyballs are motor driven, the motor supply being taken from the main generator bus through small step down transformers.

A system of carbon dioxide fire protection is provided for the ten generators. The totally enclosed air system on the tenth unit eliminated all damper controls for fire protection, such as was required on the other nine machines.

Growth of Hydro Service up to the End of 1929

By G. J. Mickler, Sales Dept., H.E.P.C. of Ont.

FOR the past few years it has been customary to present at this time a summary showing the extent to which Hydro service is being made use of by all Hydro consumers in various classes and by the average individual consumer, and to continue this practice the figures produced by the Twenty-second Annual Report of the Commission have been tabulated to present a picture of Hydro use as it stands at the end of 1929.

By referring to the report of the Commission there will be found Tables showing the revenues and consumption for Domestic and Commercial Lighting consumers for individual municipalities. These figures have been grouped together and summarized to develop averages under the various groupings of Cities, Towns and Villages, and the following Tables show not only the results for the year 1929 but figures in three year steps back as far as 1914, and for easy comparison the similar figures for 1928 from which an idea of one year's growth can be obtained.

As the figures presented tell their own story they require very little explanation. The general results again show that the cost of power to Domestic and Commercial users in the Province among Hydro customers is still on the decrease and the rate of consumption is mounting very rapidly.

Table No. I gives the data on Domestic Service for Cities of 10,000 and over population. This Table shows a healthy increase in the revenue and kilowatt-hours consumed as well as an increase of approximately 8 per cent. in the average monthly consumption per consumer. At the same time there is a reduction of from 1.55c. per kilowatt-hour to 1.51c. per kilowatt-hour in the cost to the average consumer.

TABLE NO. I.
DATA FOR CITIES OVER 10,000 POPULATION
DOMESTIC SERVICE

Year	No. of Munici-palities	Annual Revenue	Kilowatt-Hours Consumed	Number of Con-sumers	Average Cost Per kw-hr.	Average Monthly Bill	Average Monthly Consump-tion kw-hr.
		$			c.	$	
1914	12	614,925.00	12,646,400	55,597	4.86	1.06	21.8
1917	19	1,063,264.00	36,693,100	107,248	2.89	0.88	30.5
1920	21	1,926,924.00	84,328,000	154,186	2.29	1.11	48.4
1923	21	3,772,416.00	206,266,200	223,028	1.83	1.53	83.5
1926	21	5,374,069.00	324,290,285	255,109	1.66	1.80	108.0
1928	25	6,822,129.70	440,499,126	294,488	1.55	1.99	128.2
1929	26	7,530,748.75	497,102,897	309,645	1.51	2.08	137.2

TABLE NO. II.

DATA FOR TOWNS OVER 2,000 POPULATION.

DOMESTIC SERVICE.

Year	No. of Munici-palities	Annual Revenue	Kilowatt-Hours Consumed	Number of Con-sumers	Average Cost Per kw-hr.	Average Monthly Bill	Average Monthly Consump-tion kw-hr.
		$			c.	$	
1914	19	90,333.00	1,414,500	7,410	6.38	1.11	17.4
1917	27	180,375.00	3,824,600	15,731	4.71	1.01	21.4
1920	36	353,915.00	10,053,100	24,041	3.50	1.26	36.0
1923	43	651,499.00	25,411,300	34,135	2.56	1.57	60.1
1926	48	1,037,016.00	50,487,035	47,873	2.05	1.84	89.6
1928	55	1,412,058.50	68,164,403	58,740	2.07	2.04	98.3
1929	54	1,474,547.24	68,283,456	57,699	2.16	2.11	97.8

TABLE NO. III.

DATA FOR VILLAGES UNDER 2,000 POPULATION.

DOMESTIC SERVICE

Year	No. of Munici-palities	Annual Revenue	Kilowatt-Hours Consumed	Number of Con-sumers	Average Cost Per kw-hr.	Average Monthly Bill	Average Monthly Consump-tion kw-hr.
		$			c.	$	
1914	18	24,913.00	291,000	1,859	8.55	1.10	13.1
1917	77	97,516.00	1,412,500	8,334	6.90	0.96	14.0
1920	109	233,819.00	3,829,900	15,665	6.00	1.29	21.2
1923	142	531,505.00	11,429,100	29,689	4.72	1.59	33.7
1926	174	942,309.00	29,945,632	46,900	3.15	1.71	54.4
1928	188	1,177,624.28	42,346,506	54,783	2.80	1.84	66.0
1929	193	1,251,564.03	46,755,369	57,075	2.68	1.80	67.2

TABLE NO. IV.

ALL MUNICIPALITIES TOTALLED.

DOMESTIC SERVICE

Year	No. of Munici-palities	Annual Revenue	Kilowatt-Hours Consumed	Number of Con-sumers	Average Cost Per kw-hr.	Average Monthly Bill	Average Monthly Consump-tion kw-hr
		$			c.	$	
1914	49	730,168.00	14,359,100	64,866	5.08	1.06	21.0
1917	123	1,340,855.00	41,930,200	131,313	3.20	0.91	28.6
1920	166	2,514,658.00	98,211,000	193,892	2.56	1.15	44.6
1923	206	4,955,420.00	242,926,600	286,852	2.04	1.54	75.7
1926	243	7,353,394.00	404,722,959	349,882	1.81	1.79	98.4
1928	268	9,411,812.48	551,010,035	408,071	1.71	1.97	115.5
1929	273	10,256,860.02	612,141,722	424,419	1.67	2.05	122.5

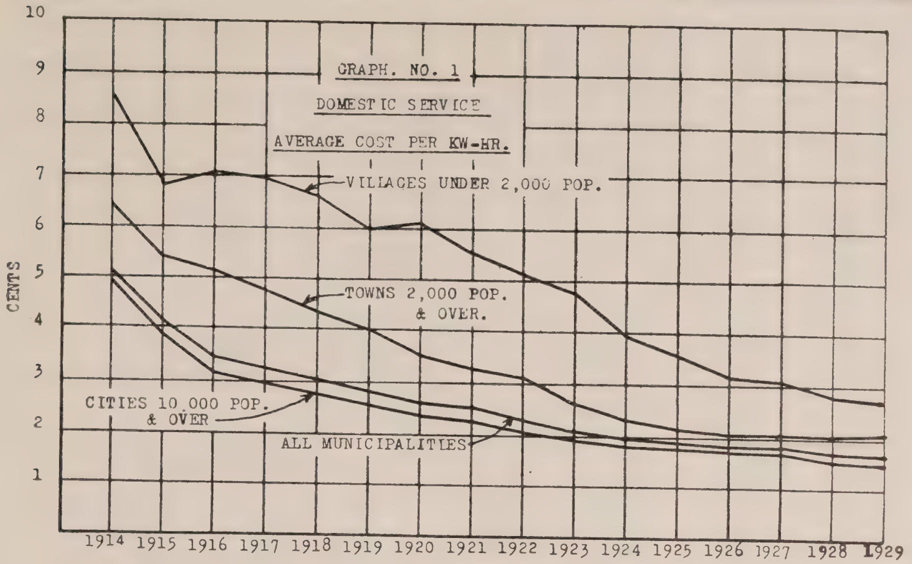


Table No. II presents the data on Domestic Service for Towns between 2,000 and 10,000 population. Increases in revenue and kilowatt-hours consumed are apparent in this Table as well as in Table No. I. There is a slight increase in the cost per kilowatt-hour to the consumer and a slight decrease in the average monthly consumption. The increased cost may be accounted for by the fact that during the year 1929 there was a slight revision made in the service charges for 3 wire services.

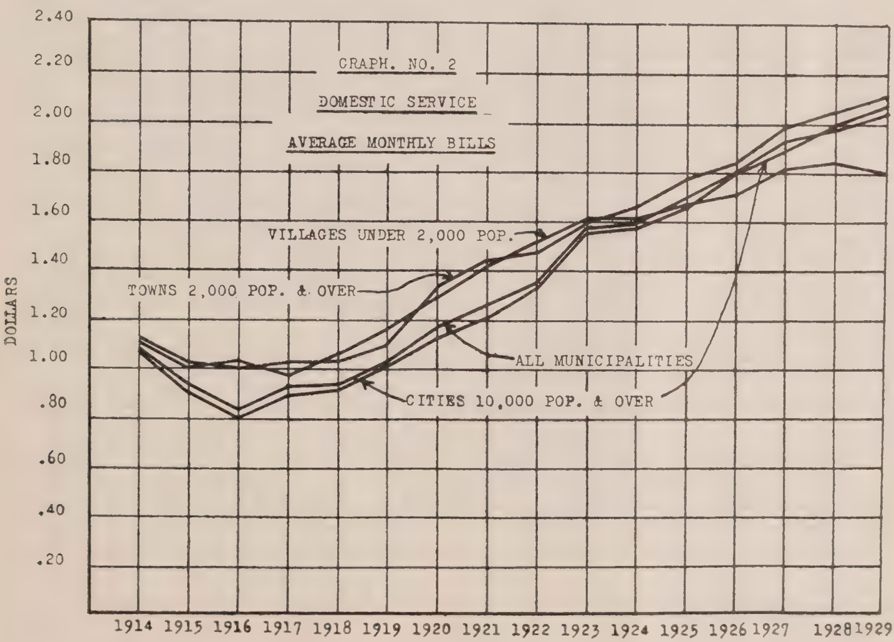


Table No. III contains the data for Domestic Service for Villages under 2,000 population, and here again increases in revenue and kilowatt-hours consumed are quite noticeable with a downward trend in the average cost per kilowatt-hour and increase in the average monthly consumption.

In Table No. IV, where all the previous Tables have been summarized, the general effect is to produce a decrease in the average cost per kilowatt-hour from 1.71c. in 1928 to 1.67c. in 1929, and an increase in the average monthly consumption per consumer of from 115.5 kilowatt-hours to 122.5 kilowatt-hours.

With an average consumption of 122.5 kilowatt-hours covering all municipalities in Ontario or an average yearly consumption of 1,470 kilowatt-hours the average annual consumption in Ontario is about three times as great as that among Domestic consumers in the United States.

There are quite a number of municipalities in Ontario in which the consumption is very much higher than the average and a few of these may be worth mentioning at this time:

Fort William—Shows an average consumption among Domestic consumers of 4,524 kilowatt-hours.

Ottawa—3,065 kilowatt-hours.

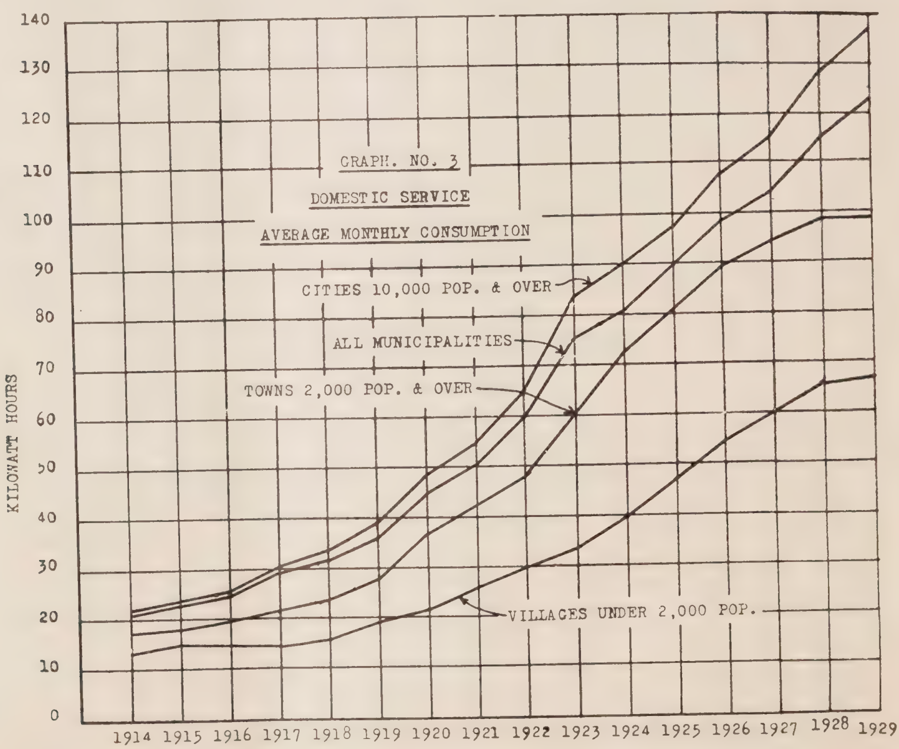
Walkerville—2,868 kilowatt-hours.

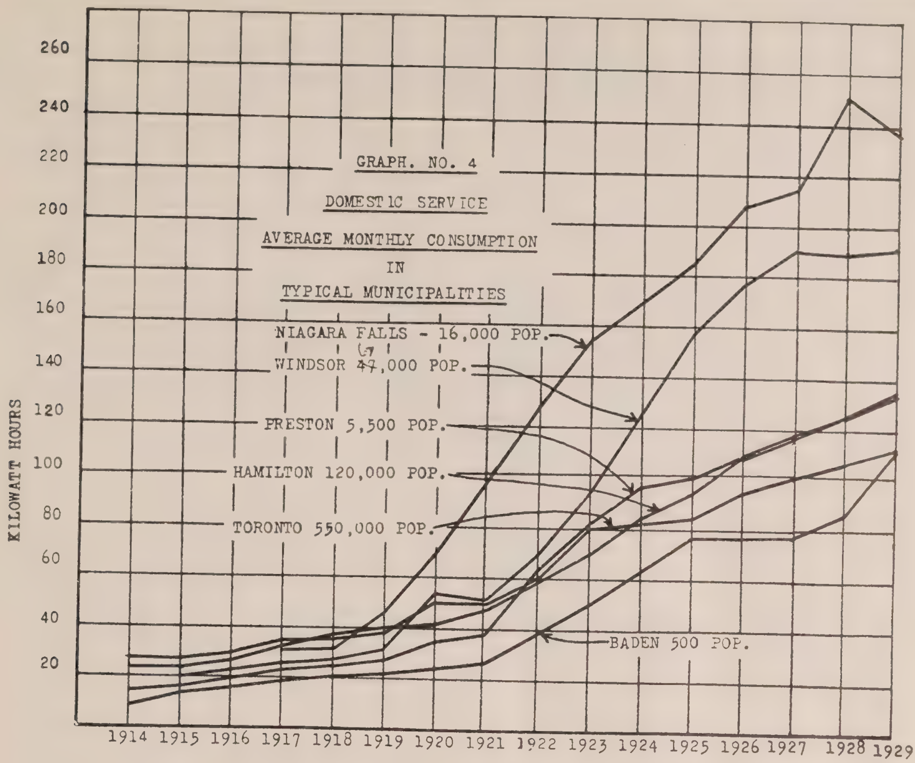
Weston—2,028 kilowatt-hours.

St. Jacob's Village—1,368 kilowatt-hours.

Port Credit—1,644 kilowatt-hours.

There are many other interesting





examples of high consumptions with low corresponding average costs per kilowatt-hour but the instances referred to give some indication of the extent to which Hydro municipalities are extending Domestic Service.

Some of the figures in the foregoing Tables have been graphically illustrated in the following graphs:

Graph No. I shows the average cost per kilowatt-hour in four curves covering Cities, Towns and Villages and one curve for all municipalities.

Graph No. II shows the average monthly bills with the same classification as in Graph No. I.

Graph No. III shows the average monthly consumption per consumer, showing the growth in average consumption for Cities, Towns and Villages.

Graph No. IV shows the growth of consumption among the consumers of six typical municipalities, all sizes of municipalities being represented.

Tables Nos. V, VI, VII and VIII give the figures for Commercial Lighting Service along the same lines as the previous Tables for Domestic Service, and in these Tables on Commercial Lighting Service the same general increases in revenue and consumption are noted as are also the decline in the average cost per kilowatt-hour and the increase in the average monthly consumption per consumer. The increase in the average consumption in all the Tables is quite marked and by referring to Table No. VIII it will be seen that the average cost per kilowatt-hour for Commercial Lighting Service has dropped from 2.32c.

TABLE NO. V.

DATA FOR CITIES OVER 10,000 POPULATION
COMMERCIAL LIGHTING SERVICE

Year	No. of Munici-palities	Annual Revenue	Kilowatt-Hours Consumed	Number of Con-sumers	Average Cost Per kw-hr.	Average Monthly Bill	Average Monthly Consump-tion kw-hr.
		$			c.	$	
1914	12	536,350.00	14,048,500	12,439	3.80	3.94	103.7
1917	19	642,989.00	27,479,800	19,573	2.34	2.96	126.6
1920	21	1,103,599.00	50,358,000	25,505	2.19	3.77	172.0
1923	21	2,043,197.00	91,146,500	32,016	2.25	5.56	246.9
1926	21	3,393,186.00	147,581,714	40,675	2.30	7.08	308.0
1928	25	4,344,623.58	197,197,540	46,862	2.20	7.70	350.0
1929	26	4,772,209.30	230,263,364	48,713	2.07	8.49	401.5

TABLE NO. VI.

DATA FOR TOWNS OVER 2,000 POPULATION
COMMERCIAL SERVICE

Year	No. of Munici-palities	Annual Revenue	Kilowatt-Hours Consumed	Number of Con-sumers	Average Cost Per kw-hr.	Average Monthly Bill	Average Monthly Consump-tion kw-hr.
		$			c.	$	
1914	17	71,457.00	1,362,000	2,393	5.25	2.61	49.8
1917	27	134,730.00	3,100,600	4,107	4.35	2.76	63.5
1920	36	221,867.00	6,179,400	5,736	3.59	3.30	91.8
1923	43	315,530.00	9,598,000	7,086	3.29	3.76	114.3
1926	48	430,467.00	15,709,616	8,310	2.74	4.31	160.0
1928	55	617,007.80	23,768,202	10,315	2.59	4.99	192.0
1929	54	632,010.30	26,240,436	10,214	2.41	5.13	213.1

TABLE NO. VII.

DATA FOR VILLAGES UNDER 2,000 POPULATION
COMMERCIAL LIGHTING SERVICE

Year	No. of Munici-palities	Annual Revenue	Kilowatt-Hours Consumed	Number of Con-sumers	Average Cost Per kw-hr.	Average Monthly Bill	Average Monthly Consump-tion kw-hr.
		$			c.	$	
1914	14	16,974.00	259,200	825	6.55	1.74	26.6
1917	77	82,756.00	1,403,100	3,773	5.86	1.87	31.7
1920	109	152,497.00	2,799,500	5,255	5.89	2.45	45.0
1923	142	254,530.00	4,738,100	7,281	4.80	2.96	55.1
1926	173	352,942.00	8,505,684	9,459	4.15	3.22	77.7
1928	188	475,163.71	13,561,089	10,836	3.54	3.65	104.2
1929	193	488,997.65	15,839,530	11,179	3.08	3.70	119.9

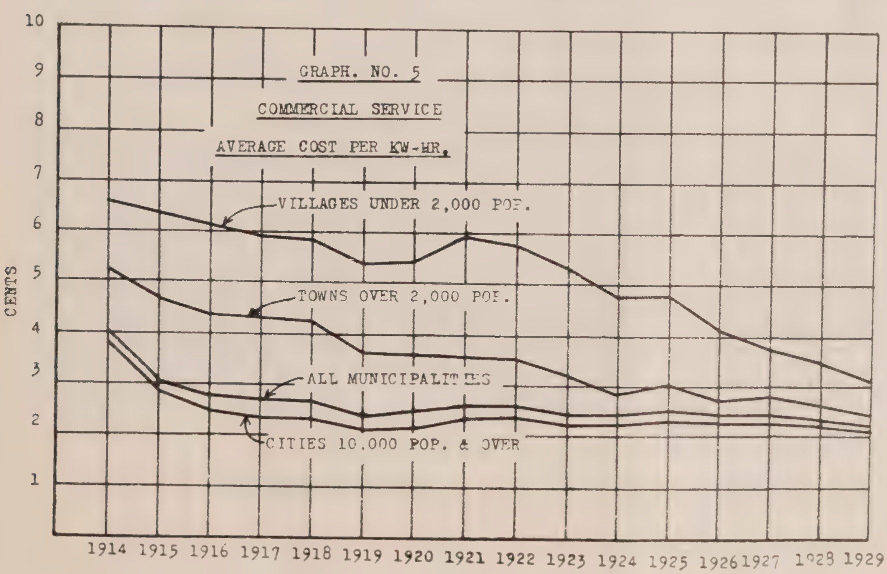
TABLE NO. VIII.
ALL MUNICIPALITIES TOTALLED
COMMERCIAL LIGHTING SERVICE

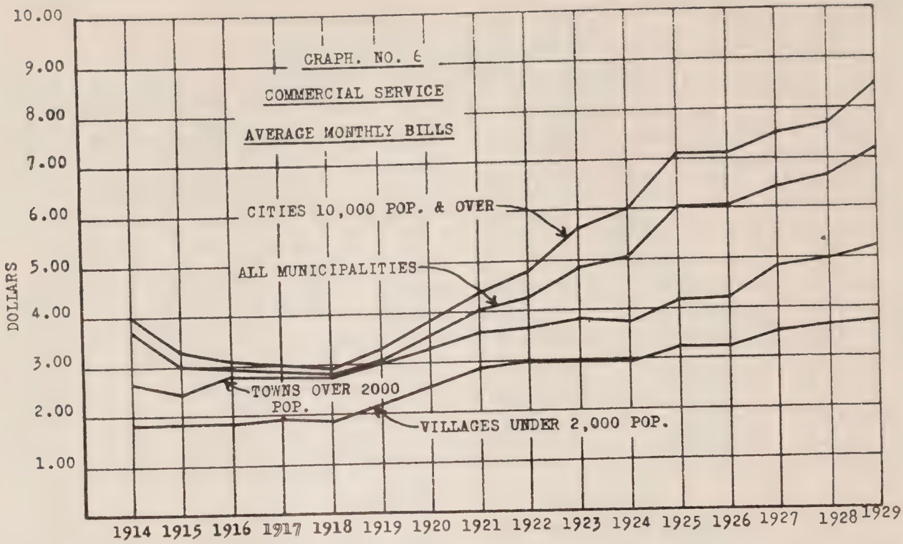
Year	No. of Municipalities	Annual Revenue	Kilowatt-Hours Consumed	Number of Consumers	Average Cost Per kw-hr.	Average Monthly Bill	Average Monthly Consumption kw-hr.
		$			c.	$	
1914	43	624,781.00	15,669,700	15,657	4.00	3.63	90.8
1917	123	860,475.00	31,983,500	27,453	2.69	2.77	103.1
1920	166	1,477,963.00	59,336,900	36,496	2.50	3.51	140.0
1923	206	2,613,257.00	105,482,600	46,383	2.46	4.80	195.6
1926	242	4,176,595.00	171,797,014	58,444	2.43	6.08	250.0
1928	268	5,436,795.09	234,526,831	68,013	2.32	6.66	287.4
1929	273	5,893,217.25	272,343,330	70,106	2.16	7.11	328.6

in 1928 to 2.16c. in 1929, and the average consumption has gone up from 287.4 kilowatt-hours per month to 328.6 kilowatt-hours per month.

The results in the last four Tables are also graphically represented in Graphs Nos. V, VI, and VII which are self explanatory.

During the past two years data have been collected on the consumption of current among Hydro Rural consumers, and in Table No. IX are shown the annual consumption figures for the years 1928 and 1929 as well as the average yearly cost for each class of rural customer. In practically every case it will be noted that there is a substantial increase in the total consumption figures in the year 1929. although by comparing these figures with those of the Domestic consumers in Cities and Towns it will be seen




GRAPH. NO. 6
COMMERCIAL SERVICE
AVERAGE MONTHLY BILLS
CITIES 10,000 POP. & OVER
ALL MUNICIPALITIES
TOWNS OVER 2000 POP.
VILLAGES UNDER 2,000 POP.
DOLLARS
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929

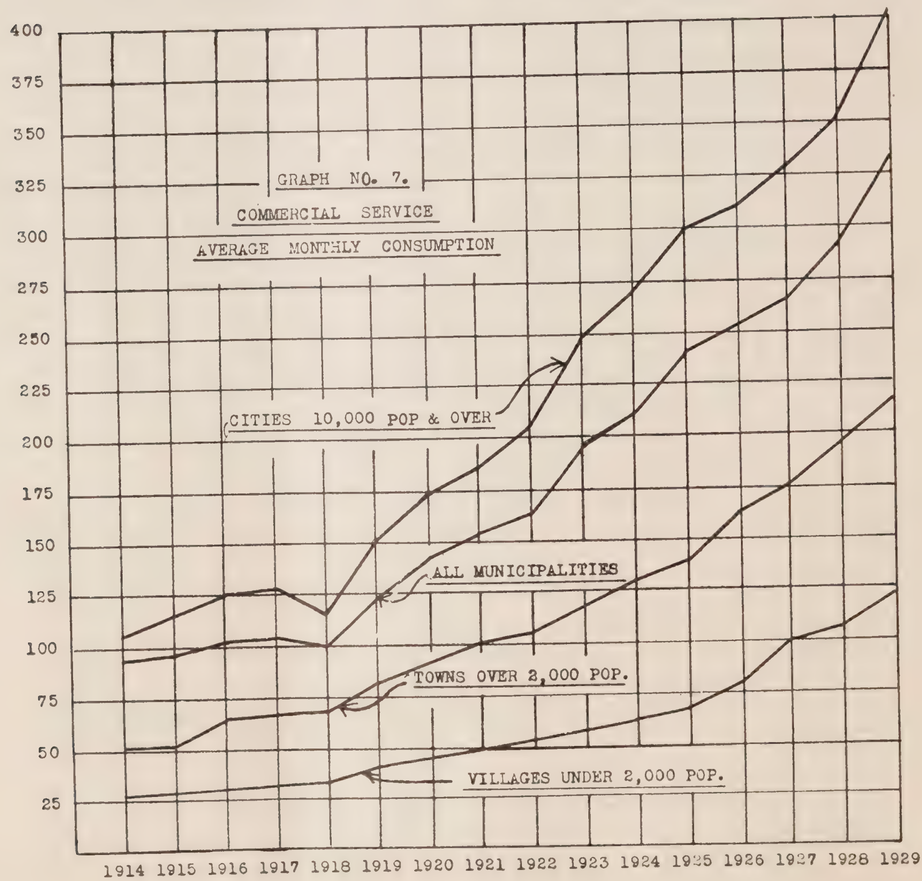

GRAPH NO. 7.
COMMERCIAL SERVICE
AVERAGE MONTHLY CONSUMPTION
CITIES 10,000 POP & OVER
ALL MUNICIPALITIES
TOWNS OVER 2,000 POP.
VILLAGES UNDER 2,000 POP.
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929

TABLE NO. IX.
SHOWING CONSUMPTION AND COST OF POWER TO RURAL CONSUMERS, 1928 AND 1929.

Class	Class of Service	Average Annual Consumption kw-hr.		Annual Net Cost to Consumer	
		1928	1929	1928	1929
				$ c.	$ c.
1 B	Hamlet Lighting.........	388	466	24.56	27.02
1 C	Hamlet Lighting.........	1,627	1,975	56.62	65.17
2 A	House Lighting..........	417	543	27.90	37.30
2 B	Small farm service........	1,093	1,314	46.45	53.48
3	Light farm service........	833	1,102	55.14	66.67
4	Medium farm service.....	2,085	2,470	87.99	98.55
5	Medium farm service.....	2,073	2,149	93.70	99.93
6 A	Heavy farm service.......	5,987	8,330	180.21	239.90
6 B	Heavy farm service.......	3,892	8,449	156.46	214.60
7 A	Special farm service......	13,579	15,590	327.25	395.98
7 B	Special farm service.......	18,438	12,982	584.48	341.42

that there is room for considerable expansion in the use of electrical equipment on the farm.

There are other statistics of equal interest which could be presented in connection with Hydro service but the foregoing Tables and Graphs give a fair indication of the extent to which Hydro service is being applied in Domestic, Commercial and Rural life and the continued growth of that service.

Application of Hydro-Electric Power to Farm Work

Article No. 21

Electric Heating of the Soil

EXPERIMENTS carried out independently in Norway, Sweden, Great Britain and the United States, demonstrate the advantages and practicability of using electricity for heating the soil in plant culture. It is demonstrated that by the use of electric heat instead of the older methods, the plant growth is stimulated to such a degree as to make this use most desirable, while costs are lowered. It is shown that this use can be made to advantage either within a green house or outside in a cold frame.

Different methods were used in applying the heat, all of which are reported to be satisfactory. In Europe the experiments were carried out with a heating element in the form of a single resistance wire insulated and sheathed to protect it from corrosion and buried below the surface of the soil. Another method is to lay drain pipe under the bed through which the cable is drawn.

Fig. 1—The plant in the electrically heated bed after 45 days.—Rural Electrification and Electro-Farming.

Fig. 2—The plant in the ordinary frame after 45 days.—Rural Electrification and Electro-Farming.

This gives protection to the cable from injury from digging and also facilitates replacing the cable should it become defective. In the United States the plan has been adopted of making the bed with a space underneath into which a special heating element with thermostatic control may be placed when desired.

The following is taken from the description of experiments given in a recent issue *Rural Electrification and Electro-Farming:*

"In the experiments conducted by the South Wales Electrical Power Distribution Company a cable made up of a single resistance wire, approximately .045 in diameter, insulated and sheathed to protect it from corrosion, was buried about 12 in. below the surface of the ordinary soil.

A Norwegian Method of placing cable for soil heating with no protection.—Rural Electrification and Electro-Farming.

without manure treatment, in a cucumber frame measuring 8 ft. by 6 ft. Current was passed through this to keep the soil at an average temperature of 70 deg. F., during approximately twelve hours of the twenty-four, but mostly during the night. Cucumber seedlings were planted in this bed, and in order to provide comparative results similar seedlings were also planted in an ordinary manure hot-bed placed in a similar cucumber frame."

The accompanying illustrations, Figs. 1 and 2, show the plants forty-five days after planting. At that time the plant in the ordinary cucumber frame had not yet even flowered, while the plant in the electrically heated frame had produced fruits, the largest of which is seen resting against the outside of the frame and measured 12 in. The rate of growth, strong shoots and leaves of the electrically heated plant prove that the experiment was successful.

"We notice that in the experiment referred to the cable was not laid in a layer of sand. This is an advantage, because the sand protects the cable as well as acting as an effective distributor of the heat. Another method of protecting the cable is by the provision of an earthenware pipe in which the cable is laid, this method facilitating the removal of the cable for repair or exchange for a cable of a different size should this be necessary."

The Detroit Edison Company has prepared a pamphlet in which is outlined their observations concerning a heating element designed to be placed in a space provided for it under the hot-bed or cold frame. The heating element referred to carries the

Heating cable protected by drain pipe.—Rural Electrification and Electro-Farming.

trade name of "Electromaster", its design being based on studies made by that company. The following is copied from the pamphlet:

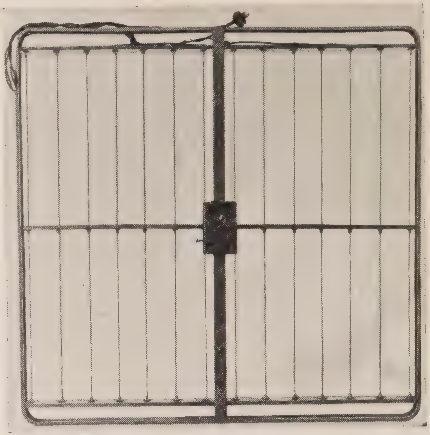
ADVANTAGES

1. Even controlled heat.
2. Inexpensive heat.
3. Automatically makes use of sunshine and warm outdoor temperatures.
4. Automatically protects plants against sudden temperature drops.
5. No electrical experience needed to build.
6. No excessive temperatures to burn plant or shrivel roots.
7. Always ready to use.
8. Clean and agreeable to work with.
9. Hotbed can be converted into cold frame simply by adjusting thermostat to low temperature.
10. Easy and economical to use compared with steam, hot water or manure.
11. Heat where you want it and no lost heat.

ELEMENT SIMPLE AND INEXPENSIVE

"The Electromaster heating element is designed for long life and is inexpensive to buy and use. It may be used on a 110-115 volt alternating current circuit. Any cycle is satisfactory. The Thermostat is adjustable, a range of 55 to 95 degrees F., being easily obtainable. Turning the screw in a clockwise direction increases the temperature. The element should be laid upon the floor of the heating compartment beneath the propagating bench, hotbed, or germinator.

Cable without protection in a British experimental frame.—Rural Electrification and Electro-Farming.



Heating element for insertion in space provided for it under hot bed or frame.—Detroit Edison Co.

"This element is rated at 275 watts, 115 volts, and is designed to maintain adequate temperatures under nine square feet of surface, even in cold weather. The lightweight but amply strong steel frame is protected against rust by cadmium plate.

"The thermostat is set to the desired temperature by placing the element in proper position under germinator, hotbed, or propagating bench, leaving it on until the bed is warmed through and the termometer registers the required temperature,

and then turning the screw to the right to increase temperature, or to the left to decrease temperature.

"The Electromaster type of unit has successfully maintained a propagating bench at 65 degrees F. during the month of September where there was no heat in the greenhouse. This test was conducted on a nursery farm near Detroit in 1930 when the greenhouse temperature ranged from 45 to 85 degrees F.

Electric Outdoor Hotbeds

"Considerable experimentation has been carried on in Washington, Missouri, and Michigan with electric heat for hotbeds. The tests which have been conducted by practical nursery-men, have shown them to be of unparalleled value. The need has been for a simple, reliable and inexpensive element, designed to give adequate and even heat distribution. This is now available in the Electromaster Heating Element.

Results are Astonishing

"The following figures on consumption are taken from tests made at the Herbert Collin Farm, R. 7, Mt. Clemens, Michigan, in connection with a study in which The Detroit Edison Company assisted.

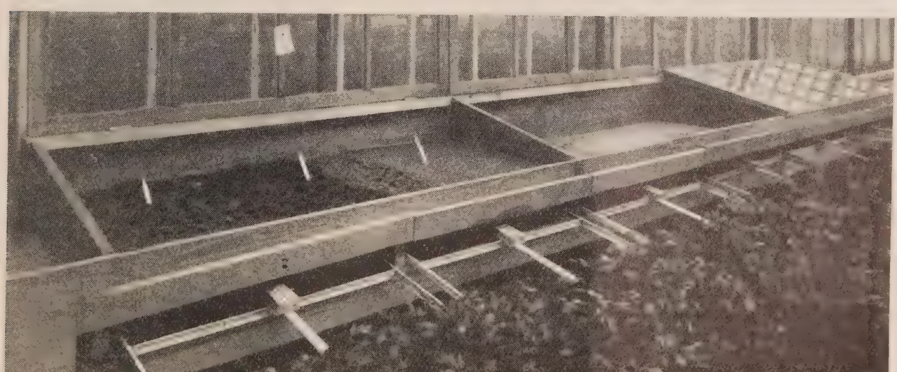
"Mr. Collin germinated 2,000,000 tomato plants in less than three months with a simple home-made 3-flat germinator, electrically heated. During the entire month of April this used about 6 kw. hr.

Operating Costs Low

"Electric heat for his propagating bench, which was 3 ft. wide and 21 ft. long, used only 296 kw-hr., during the month of September, with no other heat in the greenhouse and a greenhouse temperature of 45° to 85°.

"An outdoor, 6 ft. by 12 ft., hotbed using double wood side walls, with one inch air insulation between walls and single thickness glass cover, when average 24-hour temperature was 55 degrees, consumed during April, 1930, only 141 kw-hr.

"The electric heat kept his tomato plants in good shape while nearby manure hotbeds were frosted."



Germinator and Propogating Bench, showing method of installing heating elements.—Detroit Edison Co.

An article published in *Agricultural Engineering* describing experimental work in the United States on electrically heated hotbeds, and written by Maurice W. Nixon, contains the following information.

"The necessary heat flux varied somewhat with seasonal conditions, geographical location, and when off-peak current was used, with the total time of operation out of 24 hours. Edholm[1] reported an input flux of 55 to 110 watts per square yard and an average energy consumption of from 1.01 to 1.68 kilowatt-hours per square yard per day. Kind[2] reported an input of 105 watts per square yard and a consumption of 0.84 kilowatt-hours per square yard per day. Kind[2] also reported that 0.042 kilowatt-hours per square yard were required per 24 hours to raise the soil temperature 1.8 degrees (Fahrenheit), with the outside temperature at 32 degrees. A soil temperature of from 68 to 77 degrees which was taken 2 inches below the surface was considered as optimum.

[1] Edholm, Harald.

[2] "The Electric Hotbed for Commercial Garden and the Villa Owner." Royal Board of Directors of Waterfalls, Stockholm, Sweden, Sept. 1927. Swedish work translated into the English.

[2] Kind—"Electrical Soil Heating" from "Die Technik in der Landwirtschaft"; Vol. 10; Bk. 12, 1929. (Siemens Schuckert reprint 409/10) Translated into the English by courtesy of the Westinghouse Electric and Manufacturing Company.

"In New York state we have run hotbeds through one winter season to study their operating characteristics under extreme conditions. Three steps of heat flux were available, 37.5, 62.5 and 100 watts per square yard. The following table indicates the energy consumption by monthly periods during the winter and spring season.

"It was observed that in order to keep the hotbeds above certain minimum temperature conditions, a certain heat flux was necessary under certain seasonal conditions. Upon comparing the actual consumption each month with the available monthly consumption, it was noted that each step was sufficient for operation during certain months in the vicinity of Ithaca.

Watts Per Sash	Available Monthly Consumption
75	54
125	90
200	144

1929 - 1930	Kw-hr. per month per 3-by-6-ft. sash		Kw-hr. per day per 3-by-6-ft. sash	Kw-hr. per day per sq. yd.	
November	79		2.64	1.32	Manual regulation
December	112		3.62	1.81	Manual regulation
January	149		4.8	2.40	Manual regulation
February	73		2.61	1.30	Manual regulation
March, First 10 days	31	58	3.10	1.55	Thermostatic regulation
Second 21 days	27		1.28	0.64	Set at 32°F. outside
April, First 15 days	16.6	55.6	1.11	0.55	Thermostatic regulation Set at 32°F. outside
Second 15 days	39.0		2.6	1.30	Set at 40°F. outside

200 watts per sash was sufficient flux for December and January.

125 watts per sash was sufficient flux for November and February.

75 watts per sash was sufficient flux for March and April.

"It was further observed that to keep the air within the hotbeds above 35 degrees and the soil above 50 degrees, the following flux per 3-by-6-foot sash would be sufficient at the outdoor temperature indicated, recorded between 5.00 and 6.00 a.m.

75 watts per sash at 20 degrees (Fahrenheit).

125 watts per sash at 10 degrees (Fahrenheit).

200 watts per sash at 0 degrees (Fahrenheit).

"There was no demand for any more underheat. The three steps available were sufficient, and in fact seemed unnecessary when automatic operation was employed. Two steps would have been satisfactory.

"Many hardy plants may be started very early in the season with electrically heated hotbeds. They can be forced until time to harden them off and transplant to the field. The beds may be easily converted into cold frames for hardening off plants merely by turning off the heat. Cabbage plants, seeded on February 24 were ready to transplant in about two weeks. Other plants were as successfully forced.

"It was possible also to use the hotbeds during the winter. Radishes were planted October 15; On November 26 they were thinned and a large double handful harvested from four sash. More harvests were made on December 8 and 28, and January 22. Lettuce planted at the same time kept over winter and was successfully forced during late February and March."

With climatic conditions as exist in Ontario and the market for out of season fruits and vegetables supplied greatly by imported products, it would seem to us that this is one of the means of meeting public demands by using Hydro power to assist raising these products profitably.

The limited space available in *The Bulletin* does not permit more than the foregoing brief outline of some of the studies made of electric heating of hotbeds. For those desiring to review that work more fully, they are referred to the following in addition to the references shown in the article:

Progress Report of the Development and Uses of the Electric Hotbed or Propagating Frame.—Issued by Puget Sound, Power & Light Company.

Power on the Farm.—Prepared for Washington Farmers by Puget Sound, Power & Light Company.

Manure and Electric Hotbeds.—By Harry L. Garver and Chester L. Vincent.

General Bulletin No. 219—State College of Washington—Agricultural Experiment Station.

Chats Canal

THE development of Chats Falls on the Ottawa River has brought to mind a detail connected with the use of that river for transportation during pioneer days. One of the auxiliary dams of the development will cross and close what remains of the uncompleted Chats Canal, which was intended to permit the passage of larger river boats between Lake Deschenes and Chats Lake.

The accounts of the earlier explorers of the country to the west of Montreal show that they followed the waterways used by the Indians. The route to Lake Superior was via the Ottawa River, Mattawa River, Lake Nipissing, French River, Georgian Bay, North Channel and St. Marys River. Samuel Champlain proceeded up the Ottawa in 1613 to Allumette Island. Champlain's intention was to verify the report of an exploration party he had sent a few years previously to find a route to Hudson Bay via the Ottawa River and which had returned reporting success. At Allumette Island he learned from the Indians that his exploration party had only gone that far and then returned to Quebec. Champlain

Aerial photograph showing locks section of abandoned Chats Canal. A—Cut for entrance lock, B—Rapids, C—Excavation for pool, D—Rapids, E—Pontiac Bay, F—Old tramway. This Section is about one half-mile long. An Auxiliary dam will be built at the head of rapids marked B.—Aerial photographed by Royal Canadian Air Force.

Chats Falls on the Ottawa River from a steel engraving made about 1840. The power house location is at the left centre of this scene above the falls.

stayed some days with Chief Tessoüat who had a village and cultivated gardens near the present site of Pembroke. It was decided not to embark in any wars that season, so the French returned. In 1615, however, Champlain, accompanied by eight white men, passed up the Ottawa to Mattawa, thence to Lake Nipissing and down the French River to Georgian Bay and by the Trent Valley to Lake Ontario. The Ottawa route was favoured by the fur traders, since their heavily laden

canoes could be brought from Lake Superior to Montreal without exposure to gales, and since the trade meant only one journey up in the early Summer and back during the Autumn, no settlement was made along its route until the beginning of the nineteenth century. It was in 1800 that the first settlement was made at Hull, when a colony of five families settled there under the leadership of Philemon Wright. In 1806 Mr. Wright took out his first raft of square timber which he succeeded in conveying safely to Quebec. In 1819 he built a steam boat which plied between Hull and Grenville. Up to this time river transportation was carried on in canoes and Durham boats.

The trade and settlement had meantime extended on up the Ottawa and we find the first steamer on Lake Deschenes about 1833. In 1846 the Union Forwarding Company was inaugurated, whose steamers did all the transportation for the valley west of Ottawa during the next thirty years. The first step in this route was the eight mile drive from Ottawa to Aylmer, long famous as the Holt stage line. There was a good macadam road, and freight was forwarded by large wagons carrying as much as five tons at one load. Supplies for the lumber camps, pork, beans, molasses and tea, axes, chain and rope, were hauled daily all summer to the steamer wharf at Aylmer.

A side-wheel steamboat left Aylmer each morning for Chats Falls, 25 miles up. Passengers were landed at a low level wharf in Pontiac Bay, and elevated by a rising platform about 40 feet to the top of the rock cliff. They then embarked on a tram car drawn by two horses in tandem, and were carried three miles to the foot of Chats Lake, where they boarded another steamboat that proceeded up the lake.

Upper pool of Canal (Marked C on aerial photograph).

Rapids between upper pool and lower excavation (B on the aerial photograph).

Whether it was on account of the prospect of a continuous waterway being established between Lake Superior and Montreal via the Ottawa River, or whether it was on account of the influence of representatives of the settlements along the river west of Ottawa, and people engaged in the transportation, is not altogether clear, but in 1854 an Act was passed by the Legislature of Canada authorizing the construction of a canal, to be known as Chats Canal, between Lake Deschenes and Chats Lake. The contract was dated June 19, 1854, the contractors being Angus P. MacDonald, Chatham, Canada West, and Peter Schram, London, Canada West. The canal had a projected length of 2.8 miles with six locks 200 feet by 45 feet by 7 feet depth on sills. Locks 1, 2, 3 and 4 were to have lifts of 14 feet, 12 feet, 12 feet, and 11 feet 9-6/10 inches, respectively, the other two being the lower entrance and the upper guard locks. The canal was to be completed on or before the 12th day of June, 1857.

Payments were to be made for the work on a unit price basis, the contract reading as follows:—

> "In consideration whereof Her Majesty Queen Victoria, represented by the said Commissioners as aforesaid, doth hereby promise and agree to pay to the parties of the first part, or to the heirs, assigns, or legal representatives of the parties of the first part, the rates and prices hereinafter mentioned, viz.:—Solid rock or connected Quarry in Lock Pits, Reaches and entrance, five shillings per cubic yard—Earth in Lock Pits, reaches and entrance and borrowing Pits, one shilling and three pence per cubic yard—For chopping and clearing, six pounds per acre—For Puddling in embankments, two shillings per cubic yard —For Masonry per cubic yard, viz: —Lock walls laid in mortar as

specified, one pound fifteen shillings.—Lock walls laid throughout in hydraulic cement, one pound seventeen shillings and sixpence—Rubble walls laid in mortar, fifteen shillings ——."

Work was begun accordingly, and proceeded until November 15, 1856, when activities were suspended, and the canal was never completed.

The total expenditure on account of the work is given as $483,000. There were differences of opinion as to the value of the work done at its suspension. It is said that the contractor claimed $367,161.40, but the Government engineer fixed its value as $274,108.63; Mr. Killaly, assistant Commissioner gave $342,647.12 as a fair price while Mr. Shanly estimated it as $328,802.52. It would appear, however, that the Government paid the contractors $373,191.98.

For nearly eighty years the Chats canal has been but a small water course emptying into Pontiac Bay.

When the Chats Falls development shall have become completed the upper workings will be under water, while the lower part will appear as a part of a small dried up river ending in an excavation that was intended for the entrance lock of the Chats Canal.—*S.R.A.C.*

References:

Sessional reports of the Legislature of United Canada.

Report of W. Shanly, C.E., on St. Lawrence and Ottawa Waterways.

The Canadian Canals by William Kingsford, C.E.

Georgian Bay Ship Canal, Department of Public Works, Canada.

CJGC—London Free Press Radio Station

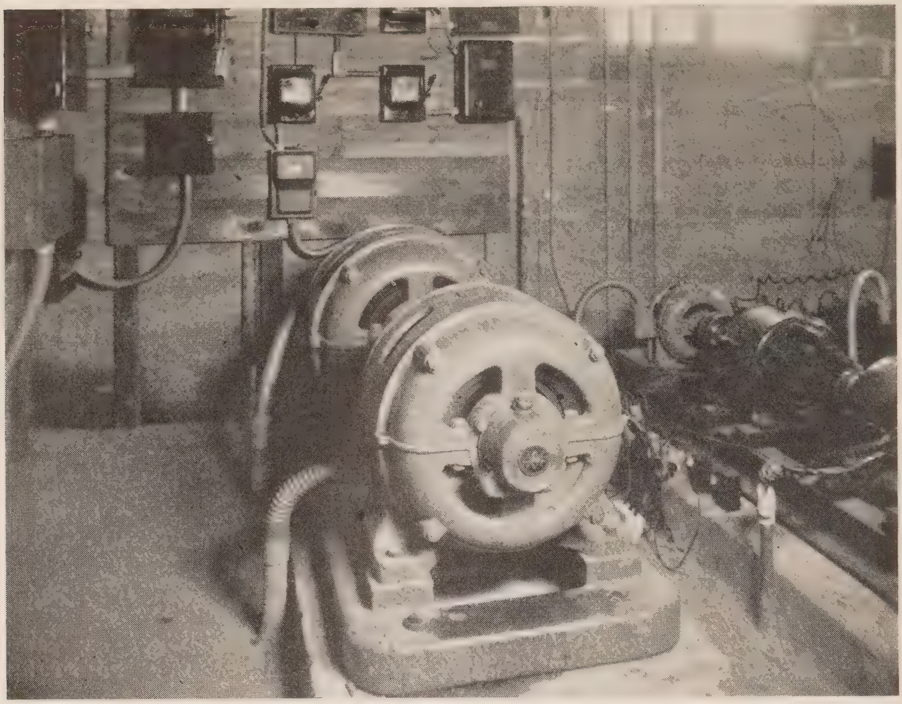
By E. W. Smithson, Asst. Engineer, Municipal Engineering Dept., H.E.P.C. of Ont.

ON the evening of October 6th, 1930, the new broadcasting station of the London Free Press, CJGC, went on the air. In order to meet the increased demand for better radio transmission, the London Free Press decided to serve Western Ontario with the best in radio by moving their broadcasting station from the City of London to an outside point.

The new station is located about 30 miles west of London on No. 2 Highway at the hamlet of Strathburn (3 miles south of Glencoe) in the Bothwell rural power district. The studios are located in London, at the Free Press Building and broadcast programmes are transmitted by means of land line telegraph to the station for broadcast on the air.

Primary power of 8,000 volts, 3-phase, 25 cycle, is supplied to a bank of 3—10 kv-a. transformers 4,600/230 volts, located approximately 400 ft. from the station building. The secondary 3-phase, 230 volt service is taken from the power bank structure by means of underground cable

CJGC Broadcasting Station showing one of the aerial towers. The aerial tuning booth is seen indistinctly at the lower right hand corner.



Equipment in the basement of the Broadcasting Station

to the equipment room in the basement of the station. The 220-110 volt service for lighting, operation of the plant water system and fuel oil heating system is obtained through a 5 kv-a. single phase air-cooled transformer located within the station 220 volts primary, 220-110 volts secondary with grounded neutral.

In the equipment room situated in the basement the power-driven apparatus is located. A 25 h.p., 220 volt, 3-phase, 25 cycle motor drives a 35 kv-a., 220 volt, 60 cycle, frequency changer which in turn supplies 60 cycle current to a 5 h.p., 220 volt, motor, which drives a 1,500 volt direct-current generator for the plate voltage of the intermediate amplifier tubes. A 7½ h.p., 220 volt, 60 cycle, motor drives a 25 volt, 150 ampere, direct-current generator for filament current of the radio tubes. 220 volt, 3-phase power, 60 cycle, is supplied for the delta primary of 3–25 kw. 220/10,000 volt transformers. The 10,000-volt secondaries are Y connected with the neutral grounded. 3-phase voltage is supplied through 3 rectifier tubes to the plate circuit of the large water-cooled 20,000-watt power amplifier. A ¾ h.p., 220 volt, motor drives the water pump for cooling this tube.

There are also 3 filament transformers, 220-volt primary, 5-volt secondary, supplying current for 3 mercury vapor rectifier tubes. It is interesting to note that CJGC was the first Canadian station to use this type of mercury vapor rectifier.

The control room presents many

interesting features. The transmitter, located in the control room, is built up in 5 panels and is operated on what is known as the unit system: that is, any of the end units may be cut in or out of service by means of a push-button control on the main control board. By means of this unit system the power output of the station may be varied from 50 to 8,000 watts. A single push-button master control switch operates all units. It will be seen that considerable flexibility in control is obtained.

The tube equipment in the station consists of one 10,000-watt, water-cooled, power amplifier, 4–250-watt intermediate amplifiers, 3–50-watt radio amplifiers and one 15-watt quartz crystal oscillator.

Grid bias voltage for the power amplifier is obtained from a 2,000 volt rectifier. Grid bias for the other tubes is obtained from wet batteries.

The aerial is of the standard T cage type and is 80 feet long with a cage type lead in of 100 ft. to a small building, known as an aerial tuning booth, located about 100 ft., from the station. Steel towers, 110 ft. high, support the aerial and are located 300 ft. apart. To ensure a fixed capacity in the antenna circuit variable within narrow limits, the slack in the aerial is taken up by means of a weight of 500 lbs. located about 6 inches above the ground in the centre of one of the aerial masts. This weight is connected to the aerial by means of a cable to the top of the mast and over a free pulley to the end of the aerial.

The apparatus located in the aerial tuning booth previously mentioned consists of a condenser and tuning coil. Thus the aerial circuit is tuned to resonance with the proper frequency of the transmitter. CJGC broadcasts on a wave length of 329 meters at a frequency of 910 kilocycles.

Connection between the studios in London and the station is handled

Interior of control room, the tube equipment is placed at the rear of the panels.

by means of a land line from London to Glencoe. From Glencoe to the station a 10-pair cable is installed. The land line from London to Glencoe is of special construction for broadcast purposes and is leased by the Canadian National Telegraphs to the London Free Press. By means of loading coils on this line practically a flat curve of frequencies is obtained from 35 to 6,000 cycles. The problem of capacity effects in the cable from Glencoe to the station was overcome by using loading coils located a mile apart, thus insuring correct reproduction at all radio frequencies. In chain programme broadcasts land line transmission from the studio to the broadcasting stations on the chain is used. Operation between studio and station is carried out by means of telephone and Morse circuits so that the station operator is in constant touch with the studio at all times.

The staff of the station consists of the Chief Engineer, Mr. Chas. Hunter, and an electrician. CJGC is on the air daily and it is anticipated that the new transmitter of 20,000-watts output will go into service during the early part of December, 1930. Prior to this time CJGC was operating at an output of 500 watts.

A Complaint and Reply

The object of electric utilities is to give continuous reliable service at all times. The general success of this effort has resulted in the attitude of the consumers to take their electric service for granted. As a result of this, should an unsatisfactory condition develop which for some reason is not promptly remedied, the consumer may assume a feeling of personal injury and express his opinion of the utility in a corresponding manner. But this is not a general rule, as illustrated in the following letters of complaint and reply which actually passed between a consumer and an official of an electric utility, copies of which have been handed us with permission to use :

The Complaint—

"We live in ———— and are among your subscribers, or customers, or clients, or whatever you call the people who buy your electric power. We have a lot of electric lights and a houseful of electrical dinguses and thingamumbobs. About all the work we do is to turn switches and in hot weather we hate to leave our electrically provided breeze and our electrically cooled drinks and our electrically furnished music even to turn a switch.

"But, alas! Into our idyllic life comes the thunder-storm. In a box on a pole near our house there resides some highly strung nervous member of your electrical system. At the first faint show of lightning in the distance or the first puff of wind, this temperamental member gives one loud pop and quits cold. Our lights go out, our music stops, our drinks grow warm and the busy hum of our thingamumbobs is stilled. We light matches and find candles which droop with the heat, dropping grease on our silk pants. We look for the 100 ace bridge hand which we had just opened but find the cards have been mixed in the darkness. Long after the storm is over a truck loaded with

wire and ladders and things draws up at our corner and men get out and climb the pole and holler at each other and do mysterious things to the inside of the box on the pole, and after a while the current comes back and we are alright until the next storm.

"If this occurred only occasionally we would accept it philosophically as we do picnics and cornet solos, but when it happens three times in one week we are driven to protest. We never attended three picnics or listened to three cornet solos in one week.

"We had a dog once who was afraid of thunderstorms. He weighed about 70 pounds and had long hair and in hot weather alternated between the brook and the flower bed. Whenever it thundered he tried to climb into our laps. We reasoned with him and petted him and whipped him and offered him bones, but to no purpose. Finally we gave him away and got a new dog.

"Perhaps you can gather a suggestion from our experience."

The Reply.

"We have the letter you sent to ———— and intend to preserve it as a classic. Any man who can retain his equanimity and his sense of humor during a recital of irritating annoyances to which he has been subjected, especially when the temperature is flirting with the one hundred mark, excites our admiration and commands our respect.

"Electricity is a peculiar matter or force. Ordinarily docile and accommodating it has a habit of now and then staging a tantrum and acting in a very untoward manner at most inopportune moments. Years of association with it make us quite familiar with its prima donna tendencies and at the same time realize that while man has been able to direct and to utilize its energies in many ways, several of which you have enumerated, mere man has never yet been able to devise such an insuperable barrier as would negative the laws of nature which seem to encourage an affinity between generated electricity and lightning. And affinities often cause trouble, even among humans.

"We freely admit that affinities are beyond our control but we are pleased to be able to tell you that in your case already we have 'got a new dog'.

"The change was made Saturday afternoon."

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

Association of Municipal Electrical Utilities

MINUTES OF EXECUTIVE COMMITTEE MEETING

The Executive Committee of the Association of Municipal Electrical Utilities met at the office of the Hydro-Electric Power Commission of Ontario on the afternoon of Tuesday, December 16th, 1930. The meeting was called to order by the President, Mr. R. L. Dobbin, at 2.00 o'clock. Others present were: Messrs. E. V. Buchanan, J. R. McLinden, R. M. Bond, O. H. Scott, A. W. J. Stewart, J. E. B. Phelps, J. E. Teckoe, C. T. Barnes, J. W. Peart, and S. R. A. Clement, members of the Executive Committee; Messrs. C. A. Maguire, President, and T. J. Hannigan, Secretary, Ontario Municipal Electrical Association; Messrs. G. J. Mickler and V. S. McIntyre, A.M.E.U. Committee members and Mr. M. White, Secretary, The Electric Club of Toronto.

This meeting was called for the purpose of discussing with Mr. Maguire and Mr. Hannigan the suggestion that the dates of the Winter Convention be changed to permit Honourable G. H. Ferguson to attend the Convention dinner as guest speaker.

Mr. Maguire outlined to the meeting the wish of the O.M.E.A. of honouring Mr. Ferguson immediately prior to his departure for England as High Commissioner to Great Britain, and that the only date on which this could be done was Friday, January 9th, 1931. After Mr. Maguire had outlined the reasons for the O.M.E.A. wishing to do this, and after an extended informal discussion of the question, Mr. Maguire and Mr. Hannigan were asked to retire while the A.M.E.U. members considered the matter further.

It was moved by Mr. J. E. B. Phelps and seconded by Mr. O. H. Scott :

THAT on account of the preparations and commitments already made, this Executive deems it inadvisable to make any change in the completed arrangements for the Winter Convention scheduled to be held on January 27th and 28th, 1931.

An amendment to this motion was moved by Mr. A. W. J. Stewart and seconded by Mr. E. V. Buchanan :

THAT in view of the commitments regarding the Winter Convention, which have already been made by the Ontario Municipal Electrical Association, and at the request of the Ontario Municipal Electrical Association to change the date, it is deemed advisable that the date of the Joint Winter Convention should be changed to include January 9th, 1931. It is also understood that any presentation to the Canadian High Commissioner should be made by and on behalf of the Ontario Municipal Electrical Association.

The amendment was carried.

It was moved by Mr. E. V. Buchanan and seconded by Mr. A. W. J. Stewart,

THAT the Winter Convention be held on January 8 and 9, 1931.
—*Carried.*

As the change in date of the Convention made it impossible for the Association to join with the Electric Club of Toronto at its luncheon on January 28th, as its guests, Mr.

White was asked to consult with his Executive and ascertain whether the Electric Club could change the date of its luncheon in the week of the Convention, from its regular day of Wednesday, January 7th, to Thursday, the 8th, so that they might still be host to the delegates at one of its luncheons.

The meeting adjourned at 4.20 p.m.

* * * *

ELECTION BALLOTS

The election ballots of the Association of Municipal Electrical Utilities will show the following as candidates for the various offices :

President—J. W. Peart, (Acclamation)
Vice-President—C. E. Schwenger and J. E. Teckoe.
Secretary—S. R. A. Clement, (Acclamation)
Treasurer—H. T. Macdonald and D. J. McAuley.
Directors—(from the membership at large):—C. T. Barnes, E. V. Buchanan, W. R. Catton, V. S. McIntyre, J. R. McLinden, J. E. B. Phelps and O. H. Scott.

District Directors—
Niagara District—A. B. Manson and R. S. Reynolds.
Central District—G. E. Chase and C. A. Walters.
Georgian Bay District — C. E. Brown and E. J. Stapleton.
Eastern District—H. S. Brown and R. J. Smith.
Northern District—T. W. Brackinreid—(Acclamation).

The election ballots will be distributed on the first morning of the Convention, January 8, and should be marked and deposited in the ballot box before the opening of the afternoon session on that day, 2.30 p.m. The results of the election will be announced before the close of that session.

* * * *

CONVENTION PAPERS

The programme of papers obtained by the Papers Committee of the Association of Municipal Electrical Utilities for the 1931 Winter Convention will be as follows:—

THURSDAY, January 8th, 1931 :

Morning, 10.30 o'clock—
Business Meeting and Reports.

Aflernoon, 2.30 o'clock—
"Time Payment Sales", by Mr. Emo, Industrial Acceptance Corporation, Toronto.
"Wooden Poles", by M. J. Bell, Sr., Bell Lumber & Pole Co., Minneapolis, Minn.

FRIDAY, January 9th, 1931 :

Morning, 9.30 o'clock—
"Dealing with the Public", by A. G. Evans, Asst. Chief Inspector, Toronto Hydro-Electric System.
"Public Utilities Reduce Radio Interference", by H. O. Merriman, Inductive Interference Engineer, Radiotelegraph Branch, Dept. of Marine and Fisheries, Ottawa, Canada.

Afternoon, 2.30 o'clock—
"Power Factors of Small Loads", by A. W. Murdock, Asst. Engineer, Municipal Engineering Dept., H.E.P.C. of Ont.
Question Box.

Hydro News Items

Eastern System

By-laws covering the purchase of the Tweed distribution system by the municipality of Tweed from this Commission will be submitted on December 29th, 1930.

* * * *

Estimates on the cost of a distribution system have been forwarded to the Village of Bath. It is expected that a vote will be taken on January 5th, 1931.

* * * *

Niagara System

Wallaceburg ornamental street lighting system was turned on on November 8. This system consists of 50—300 watt multiple lamps in ornamental standards and supplied by an underground cable.

* * * *

The installation of the balance of the necessary equipment at Toronto-Leaside Transformer Station to receive and control the complete allotment of power under the 25-cycle contract with the Gatineau Power Co., is rapidly nearing completion. The fourth 45,000 kv-a. bank of transformers was placed in service in September 29, 1930, and during November, 1930, the third 25,000 kv-a. condenser and the outdoor metal-clad 13 kv. switching equipment for transformer bank No. 3 were placed in operation. It is expected that the fourth 25,000 kv-a. condenser and the outdoor metal-clad 13 kv. switching equipment for bank No. 4 will be completed and in service before the end of 1930.

With the completion of this work, the station comprises,—

1. 180,000 kv-a. capacity in 3-winding, 220 kv. transformers with under-load tap changers.
2. Four 25,000 kv-a. outdoor vertical shaft synchronous condensers and their necessary starting and running equipment.
3. Switching equipment for 2–220 kv. incoming circuits, 2–110 kv. outgoing circuits, 14–13 kv. outgoing circuits.

Field construction on the station was commenced in January, 1928, Thus, within three years the construction programme required for receiving and controlling 220 kv. power, under the contract with the Gatineau Power Company, will have been completed. Initial operation of this station commenced on October 1st, 1928.

* * * *

Rural

The program outlined for Hydro Rural Extensions for the Fiscal year ending October 31st, 1931, calls for the erection of lines in various districts operated by the Commission as follows :

South-western Ontario	1,051	miles
Northern Ontario....	292	"
Eastern Ontario......	519	"
	1,862	miles

It is estimated that these additional lines will serve approximately 9,700 additional rural consumers and that 3,700 consumers will be added to existing lines. The cost of construction to give service to these consumers will be in the neighborhood of $4,380,000.

Applications received during the first month of the Fiscal year total 460, requiring 149 miles of line or about 8 per cent. of the year's program.

* * * *

The following is a copy of a letter received by the Commission recently. No comments are necessary.

no 28 1930

the Hydro Power toronto

gentelmen

as i have just got the secken bill from the hydro Co now i want to in form you that i have no hydro in my house or primis i was asked to sigen a card to make up a numbr of 6 which was lacken to get the line run in the Village and when a nother man came round with the names on the list i had him cansel my nam as i had no intenchen of in staling ligats in our home at all so you neadent be sending eny more dunners to me as have no notchen of hydro ligats at all.

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THE BULLETIN

VOL. XVIII No. 1 JANUARY, 1931

Hydro-Electric Power Commission of Ontario

Virgin Falls on the Nipigon River

HYDRO MUNICIPALITIES

EASTERN SYSTEM

Alexandria	2,300
Apple Hill	350
Arnprior	4,119
Athens	602
Belleville	13,914
Bloomfield	540
Bowmanville	3,662
Braeside	550
Brighton	1,311
Brockville	9,191
Cardinal	1,284
Carleton Place	4,293
Chesterville	965
Cobourg	5,378
Colborne	923
Deseronto	1,351
Finch	377
Havelock	1,421
Kemptville	1,298
Kingston	22,368
Lakefield	1,423
Lanark	581
Lancaster	560
Lindsay	7,056
Madoc	1,067
Marmora	1,023
Martintown	357
Maxville	746
Millbrook	703
Napanee	2,990
Newcastle	590
Newburgh	414
Norwood	764
Omemee	481
Orono	700
Oshawa	24,194
Ottawa	127,332
Perth	3,698
Peterboro	22,798
Picton	3,315
Port Hope	4,600
Portsmouth	620
Prescott	2,757
Richmond	362
Russell	500
Smith's Falls	7,178
Stirling	879
Trenton	5,777
Tweed	1,236
Warkworth	500
Wellington	912
Whitby	5,307
Williamsburg	200
Winchester	1,004
Total	308,821

GEORGIAN BAY SYSTEM

Alliston	1,342
Arthur	952
Bala	332
Barrie	7,311
Beaverton	970
Beeton	560
Bradford	884
Brechin	255
Cannington	878
Chatsworth	257
Chesley	1,772
Coldwater	615
Collingwood	6,126
Cookstown	635
Creemore	610
Dundalk	594
Durham	1,722
Elmvale	600
Elmwood	350
Flesherton	454
Grand Valley	583
Gravenhurst	1,776
Hanover	2,626
Holstein	285
Horning's Mills	350
Huntsville	2,608
Kincardine	2,352
Kirkfield	138
Lucknow	1,147
Markdale	798
Meaford	2,729
Midland	7,826
Mount Forest	1,823
Neustadt	431
Orangeville	2,721
Owen Sound	12,368
Paisley	700
Penetanguishene	3,615
Port Carling	406
Port Elgin	1,261
Port McNicholl	831
Port Perry	1,185
Priceville	
Ripley	423
Shelburne	1,135
Southampton	1,718
Stayner	968
Sunderland	570
Tara	441
Teeswater	817
Thornton	200
Tottenham	545
Uxbridge	1,425
Victoria Harbor	1,104
Walkerton	2,134
Waubaushene	600
Wiarton	1,831
Windermere	123
Wingham	2,362
Woodville	405
Total	92,579

NIAGARA SYSTEM

Acton	1,903
Agincourt	612
Ailsa Craig	500
Alvinston	635
Amherstburg	2,987
Ancaster Twp.	4,124
Arkona	371
Aurora	2,596
Aylmer	1,992
Ayr	781
Baden	710
Barton Twp.	1,597
Beachville	503
Belle River	768
Blenheim	1,631
Blyth	618
Bolton	600
Bothwell	603
Brampton	4,993
Brantford	32,786
Brantford Twp.	7,301
Brigden	400
Bridgeport	500
Brussels	706
Burford	700
Burgessville	300
Caledonia	1,475
Campbellville	200
Cayuga	671
Chatham	16,104
Chippawa	1,450
Clifford	461
Clinton	1,936
Comber	800
Cottam	333
Courtright	394
Dashwood	350
Delaware	350
Dorchester	400

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Charles A. Magrath

ELSEWHERE in this issue will be found Mr. C. A. Magrath's address, delivered at the Convention luncheon of the Ontario Municipal Electrical Association and the Association of Municipal Electrical Utilities. In his address Mr. Magrath spoke of his request to the Prime Minister of the Province to be relived of the office of Chairman of the Hydro-Electric Power Commission of Ontario.

It is with great regret that the members of the Commission's staff

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January, 1931

have learned of the Chairman's desire in this matter. Those who, during the past five years, have come into contact with Mr. Magrath will always look back upon such meetings with pleasure, both on account of his quiet dignity and the sympathetic reception always given to the matters brought to his attention. Such qualities, added to those manifested upon occasions when he has attended general staff and municipal functions, have inspired respect and esteem for the Commission's Chairman.

Since it is Mr. Magrath's wish to withdraw from some of the burdens of active public life, *The Bulletin*, on behalf of the staff, expresses the hope that he may long be spared to enjoy the leisure which he has so well earned.

Chairman C. A. Magrath's Address

To Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Toronto, January 9, 1931

THE Hydro-Electric Power Commission, with its associate municipal systems, is not a theory. It is one of the largest business organizations in Canada, with an investment well over $300,000,000. Its main responsibility is to be always in a position to supply the needs of the people in some 600 odd municipalities in Ontario with electrical power, at the lowest possible cost consistent with the proper maintenance of the property. Five years ago when I came to the service, our surplus supplies were at the low water mark and power from steam was under consideration. We managed to arrange for hydro-electric power from the Province of Quebec at a figure considerably less than power from steam would have cost. The Commission has been able to secure additional supplies from Quebec to be delivered in blocks from time to time during the next seven or eight years.

What are the Future Power needs of the Province of Ontario?

That is a question that no one can answer. We know that the Province is a storehouse of wealth that has hardly been touched as yet. This vast Province has a population of only 3,000,000 people. The City of London has over twice that number. I will not take time discussing the possibilities of Ontario's growth. In its development, electrical power will

be increasingly required. You know the rapidity of growth of the United States. Many of you may have heard the statement over the radio from Washington a week ago that, in the past 30 years in that country, the use of electricity has increased 66 times greater than the growth of population.

How is Ontario to meet its Future Power Needs?

Practically the only available undeveloped power sites within reasonable distance of the thickly settled portions of the Province are in the Interprovincial stream—the Ottawa River—and in International waters—mainly the St. Lawrence River. When we think of our undeveloped wealth—our present population and the amount of power now in use, we at once appreciate the total inadequacy of supply from our half share of power from the two sources. The probabilities are they will not take care of the increased demand beyond 15 or 20 years—when the Province will have to turn to coal for the production of electrical energy.

Purchasing of Power in the Province of Quebec.

My conception of a publicly owned power organization is that it has responsibilities far greater than a privately controlled organization. The former is more or less linked up with the development of the Province and it must always have available power supplies.

There has been a good deal of loose talk about the Commission not making more headway in developing provincial sites in the St. Lawrence and Ottawa Rivers. You of course know about the dispute between the Federal and Provincial Governments over surplus waters in what are known as navigable streams. It is very easy to understand two separate individuals disputing over certain property or rights in same, but in this case it is the same people in conflict with themselves — namely all the people of Canada as represented by the Federal Government engaged in a dispute with the same people as represented by the Provincial Governments—not a particularly intelligent proceeding. So much for the Canadian situation. My opinion is that there are issues on the United States side of the boundary requiring adjustment fully as great if not greater than those in Canada.

As for the Ottawa River, the Georgian Bay Canal interests claimed ownership of its power sites. I had a call not very long after I became Chairman of the Commission from one who said he represented the Company. He told me very frankly, amongst other things—that the two Provinces had no rights in the Ottawa River sites, a statement I certainly did not agree with. He went further and said if the Provinces attempted to develop power, it could be taken from them by the interests he represented. They were, however, willing to develop and sell power to the Commission at the Carillon and Chats Falls sites.

The Georgian Bay Canal interests failed to get their charter renewed a few sessions ago and the Commission is now engaged with Quebec interests in developing the Chats Falls site. If the Commission is not to buy power in Quebec, as seems to be in

the minds of some, then I fear the Upper Ottawa River sites will remain undeveloped for some years. The Chats Falls development was only made possible through the willingness of the Commission to buy Quebec's share from the Quebec interests, as there is no market on their side of the river at the present time. All this talk there has been about transmitting power from Quebec into Ontario is, I regret to think, political.

There is no more promising country in the world than Canada. It occupies a strategical position between the Atlantic and the Pacific oceans. In its present population it has a fine foundation stock. Surely we Canadians are not going to think and act in separate municipal, county or provincial compartments. If Ontario can offer a market for power supplies from the much greater sources of supply in Quebec and thereby increase opportunities for our people, these opportunities become national—a benefit to all the country. In short the buying of power from Quebec will bring splendid returns to Ontario and likewise to Quebec as well.

Export of Power to the United States

For the Province of Ontario to be buying considerable blocks of power from the Province of Quebec and then to talk of export of power from Ontario to the United States is begging the question. What always seems to be lost sight of is the fact that where any interests only control half a stream, there must be close co-operation with the interests controlling the opposite side. A homely simile is the relationship between two horses hitched to a wagon. There must be team play between them if the load is to be successfully cared for. The situation at Chats Falls already referred to is an evidence of that. This condition must be recognized, namely, that it is absolutely essential in the joint development of a single power site by two separate corporations, that there must be some leeway allowed to both in order to work out the most economical dealing with the power from the entire site. The Commission has had some loose or off-peak power and owing to the cordial relations between the Commission and the U. S. Power Company at Niagara Falls it has been able to obtain quite a considerable revenue for some surplus supplies. The Commission is not obligated to deliver a single kw. to those interests. That is all there is to that situation.

Hydro in Politics

You have heard something about this suggestion. Now that Mr. Ferguson has retired and Mr. Sinclair has withdrawn from the leadership of his Party, I can refer to both. I have had many years in public service work in various parts of Canada. I have served under Conservative, Liberal and Progressive Prime Ministers, and it is well known throughout the country that in my work I have known no political party. Respecting Mr. Ferguson, as head of the Government, I had to see him frequently. His treatment of Hydro was irreproachable. I had no personal contact with Mr. Sinclair as leader of his party, but he, too, has in no way,

in his political position, attempted to embarrass the Commission.

I am aware that there are some who seemed to think that I, as Chairman of the Commission, should announce what the Commission was about to do from time to time. In all of such cases, the question called for Government action. The people of Ontario never gave me authority to use the credit of the Province. Mr. Ferguson had to take the responsibility of going before the Legislature and obtaining the necessary credit for Hydro. He will indeed be a peculiar Prime Minister that has such a responsibility resting on him and not be sufficiently interested to give publicity to the programme that he has to sponsor in the Legislature. The really important point is as to who is responsible for the programme.

Technical Services of Hydro and Associate Municipal Systems

The commodity in which the Commission deals goes into most of the homes, commercial houses and industrial plants in this Province. The provincial organization delivers under the control of its engineers at municipal boundaries, the power to the technical men of the municipalities. Through these technical men cooperating, practically everything that is being done by the Commission has been understood throughout the entire system. The Commission has however refrained from discussing its problems through the press because it felt that it would be injudicious to do so in view of the difficulties surrounding much of its work.

Every problem dealing with power needs and sources of supply has been thoroughly studied out by our technical staff. In respect to the power needs, the Commission in addition has gone to outside sources for supporting testimony. Every contract that the Commission has entered into, either in respect to purchasing properties, power supplies or the development of power, has been most carefully examined by our technical staff. Working in conjunction with our own legal officers, we have at times brought in some of the leading Counsel of this Province. Finally, we have freely used Mr. Clarkson and Mr. Guilfoyle of the firm Clarkson, Gordon, Dilworth, Guilfoyle and Nash to look into all such contracts from the economic standpoint. In short everything was done that was humanely possible to do, to protect the interests of the people in these matters.

The Management of Hydro

First it must be understood that Hydro is a great commercial undertaking. The road side is littered with corporations that have gone under and principally from one cause —inefficient management. Any undertaking can be wrecked through bad management. I am not suggesting for an instant that that is to be the fate of Hydro. It is always well, however, to look conditions in the face. There are three things necessary for Hydro—capable technical men, cheap money and sound business administration.

In respect to technical men—I have referred to our engineering service and those of the municipal systems. It gives me very great pleasure to be able to say without fear of contradiction that Hydro's engineering

services are to-day recognized in the very front rank of the electrical profession. In the matter of funds for Hydro's development work, no organization in any country can find cheaper money, if in fact any can get money for their needs at as low a figure. This of course is due to Hydro having the endorsation of the Province.

Finally, as to the question of administration. That brings me to the Commission. I have told you of the care it has exercised in various matters before it in the past five years. You will be interested in knowing that every question it has dealt with has been agreed to unanimously. Do not misunderstand me. We had our differences at times but on such occasions, as Chairman, I always preferred to allow the issue to stand for further consideration until we all reached common ground—no sounder method, in my opinion, of looking after the affairs of the people.

I am aware that our forces in the field have at times caused some irritation. It was not intentional. It must be remembered that Hydro has been expanding very rapidly; that it was carrying on work all over this Province and to take care of the work our employees at times were being driven fairly hard. The Commission has had numerous conferences with representatives of the municipal systems and various other interests as well. I am sure one and all will support me when I say they were sympathetically received and every effort made to do what we could for them, consistent with certain fixed principles necessary in such an organization.

Turning to the composition of the Commission, there is Mr. Maguire who was selected at the instance of the municipal organizations and who has always actively kept in touch with the municipalities. While the Honourable Mr. Cooke is a member of the Provincial Government, in his Hydro work, he has known no politics. I am speaking for Mr. Maguire as well as myself when I say that Mr. Cooke has a wide and intimate knowledge of the Commission's work and on no single occasion has he ever directly or indirectly approached any question from a political point of view.

Now as to the third member. The only complaint I have against Mr. Ferguson is that for some time past I have tried to get him to release me. Mr. Henry, however, I anticipate will give the matter early consideration. One cannot be associated with such a magnificent property and leave it without deep regret, especially in view of the most cordial relations that have existed between myself and my associates on the Commission, the staff and the other members of the organization, all of whom have treated me with every consideration. I have never been surrounded by more loyal supporters.

When the time comes, I am satisfied that the Honourable Mr. Henry will give the question of the selection of the third member the most careful consideration. I can say this to whoever takes the responsibility, that while it takes time to get the confidence of the people, there is no honour that could come to him that will commence to yield the satisfaction and real pleasure as the knowledge that the people trust him.

If we have faith in our people and in our country there seems to be but one policy for Hydro in the Province of Ontario, and that is to move forward with confidence. The demand for power while making a substantial average annual increase, that increase will fluctuate during the periods of depression and prosperity. Because of that, it is my opinion that the cash reserves of the Commission should be well maintained until at least the power from the St. Lawrence River is fully in use.

It must be gratifying to every citizen of Ontario that through the payment of a considerable sum Hydro two years ago cleaned up all outstanding matters with the Provincial Government. The Commission meets its annual interest payments as well as sinking fund requirements promptly, and in addition is building up substantial reserves.

As we will not have the pleasure of meeting again, I want to say that I am deeply grateful for the generous support that has been extended to me from all interests in the Province. In going, I am thinking of the Commission. A time comes when we all have to make way for others.

Hydro Progress during 1930

By C. A. Magrath, Chairman, H.E.P.C. of Ont.

OUTSTANDING features that appertain to the supply of electrical service by the co-operative electrical undertaking of the municipalities of Ontario administered by the Hydro-Electric Power Commission—so far as these are revealed by the preliminary data available prior to the close of the year—point to the year 1930 as having been characterized by continued progress.

Substantial growth is indicated in the scope of operations; in the capital investment — now about $358,000,000; and in the extension of facilities for widespread utilization of electrical service—now received by the citizens of 668 municipalities. Exceptional growth has been recorded in rural electrification. In pursuance of the principle that constantly has been held in mind as fundamental to success, the financial position of the undertaking has been further strengthened, and it is anticipated that the forthcoming annual report will show the aggregate reserves and surplus to have increased during the year from $90,000,000 to about $105,000,000.

Power Loads Increased

In October, 1930, the power supplied by the Commission aggregated 1,260,000 horsepower. It is a gratification to observe that notwithstanding the general industrial depression the loads supplied by the Commission to municipalities have increased during the past year. Of the increase which has occurred, a substantial part is due to the recent acquisition by the Commission of the undertakings of the Dominion Power and Transmission Company, of the Wahnapitae Power Company, and of the Madawaska system, which

were previously served by other organizations.

FUTURE POWER SUPPLIES ASSURED

If there is one obligation more than another resting upon the Commission, it is to keep the Province of Ontario well supplied with power. It is power developed, ready for use, and not undeveloped power sites, that a rich Province like Ontario requires for the development of its magnificent resources. Periods of depression will come and go, but they are mere incidents in the expansion of a country with such possibilities as Canada.

Owing to the length of time which necessarily must elapse between the planning of large new hydro-electric developments and the actual availability of the resulting new power supplies, it is essential for the Commission to act several years in advance of the actual materialization of the demand for additional power. The Queenston - Chippawa development was commenced in 1917; power was first available in 1922, and the plant completed in 1926, at which time the power available from this great development was in use.

In facing the problem of providing ample supplies of electrical energy for the future needs of the co-operating municipalities, the Commission, of course, has fully appreciated the fact that the Province has avilable, on the Niagara, St. Lawrence and Ottawa Rivers, reserves of undeveloped power. While these reserves are very considerable, it must nevertheless be remembered that Ontario's demands in the future will exhaust them in no lengthened period of time. Furthermore, the power sites in these waters are involved in international and interprovincial difficulties, which require time and serious effort to adjust. There is also the important fact that, even after arrangements are made for commencing work on very large power sites, it usually takes several years before developments of such magnitude can be completed.

GATINEAU RIVER DEVELOPMENT

After weighing all the circumstances—including the production of power from fuel—it was considered best in the interests of Ontario, as well as most favorable to the general development of Canada, to enter into a contract for the purchase of power from developments on the Gatineau River which were then under construction. The anticipated additional requirements of the Niagara system for use at the present time were, therefore, provided for in 1926 by means of a contract with the Gatineau Power Company for 260,000 horsepower, of which 250,000 horsepower is in use at the present time.

Following this contract for Gatineau power the Commission was able to enter into satisfactory arrangements with Quebec interests owning part of the interprovincial power site at Chats Falls on the Ottawa River for the co-operative development of this site. About 224,000 horsepower will be made available to the Commission from this site. First delivery will probably be made in 1931.

DOMINION POWER ASSETS ACQUIRED

In passing, it may be commented that during the year the Commission has acquired, for an investment of

$21,000,000, the assets of the Dominion Power and Transmission Company. The physical features of the power developments included in these properties are such as to make them particularly advantageous for co-ordination with the other power supplies of the Niagara system, and their acquisition by the Commission makes possible the effecting of economies for the power consumers of the Niagara system as a whole, including those formerly served by the company. Other important properties acquired from the company will also be capable of being put to more effective use by the Commission and the municipalities, notably through gradual elimination of duplication previously existing.

The immediate and more pressing needs being thus provided for, the Commission next sought to ensure to the Province such supplies of power for the next few years as would enable it to plan with confidence for a continuance of the industrial expansion and general progress which has characterized its recent history.

To this end the Commission made a contract with the Beauharnois Power Company for 250,000 horsepower from its St. Lawrence River development. It also has made a contract with the McLaren interests for 125,000 horsepower from a development on the Lievre River.

The foregoing outlines the present provision for the Niagara system.

Power for Eastern Ontario

The early needs for Eastern Ontario were provided for by a second contract with the Gatineau Power Company for 100,000 horsepower of 60-cycle power. The districts comprised in the Eastern Ontario system are already taking 18,000 horsepower under this contract.

Looking forward to further development in Northern Ontario, more particularly perhaps in connection with mining and pulp and paper activities, the Commission had an opportunity to contract with the Ontario Power Service Corporation for 100,000 horsepower. The Commission's co-operation in this matter, it is believed, has been of assistance to general Canadian development through aiding the Ontario Power Service Corporation to provide power for a large new pulp and paper concern contemplating locating in the district.

For Northwestern Ontario similar forehanded action has been taken, and while the capacity of the Cameron Falls development was being reached, the new Alexander development of 54,000 horsepower, planned and commenced some years ago, has been constructed by the Commission and is now ready to care for expansion in the immediate future.

Altogether, the Commission — broadly speaking—has provided, to meet the needs of the future, a supply of some 800,000 horsepower, which will bring the total in use in the next few years up to about 2,000,000 horsepower.

Record Growth in Rural Supply

In 1930 nearly 1,900 miles of rural distribution line were constructed by the Commission to serve Ontario agriculturists. This record surpasses all previous records of rural distribution line construction by 60 per cent. The increase in the number of rural

consumers in the fiscal year 1930 was about 9,300, constituting an increase for all classes of 25 per cent. The increase in the number of isolated farm consumers, as distinguished from rural residents more closely grouped in hamlets, was at the rate of 30 per cent. Even more encouraging is the accelerating tendency to rapid increase in utilization of electrical energy by the farmers as individuals; recently the annual energy consumption by the 'average farm consumer' has been growing at the rate of nearly 30 per cent. per year. No finer testimony than these results to the value of an economical electrical service could be found.

Port Colborne Transformer Station

By A. N. Hunter, Assistant Engineer, Electrical Engineering Dept., H.E.P.C. of Ont.

THIS new 110/13.2 kv. transformer station was constructed to supply the increased load in the Port Colborne district and also to replace the old 30/12 kv. transformer station which had to be dismantled on account of the site on which it was situated being expropriated by the Department of Railways and Canals for the right-of-way of the new Welland Ship Canal.

The station layout is designed for an ultimate transformer capacity of 60,000 kv-a. and is of outdoor construction with the exception of the control and low voltage service equipments which are installed in a brick control building. The initial installation consists of two 110 kv. incoming line switching equipments, two banks of three 5,000 kv-a., 63.5/13.2 kv., 25 cycle, single phase, oil-insulated, self-cooled, outdoor type transformers (and one spare) with necessary high and low voltage switching equipment and four 13.2 kv., outgoing feeder equipments.

110 kv. Switching Equipment

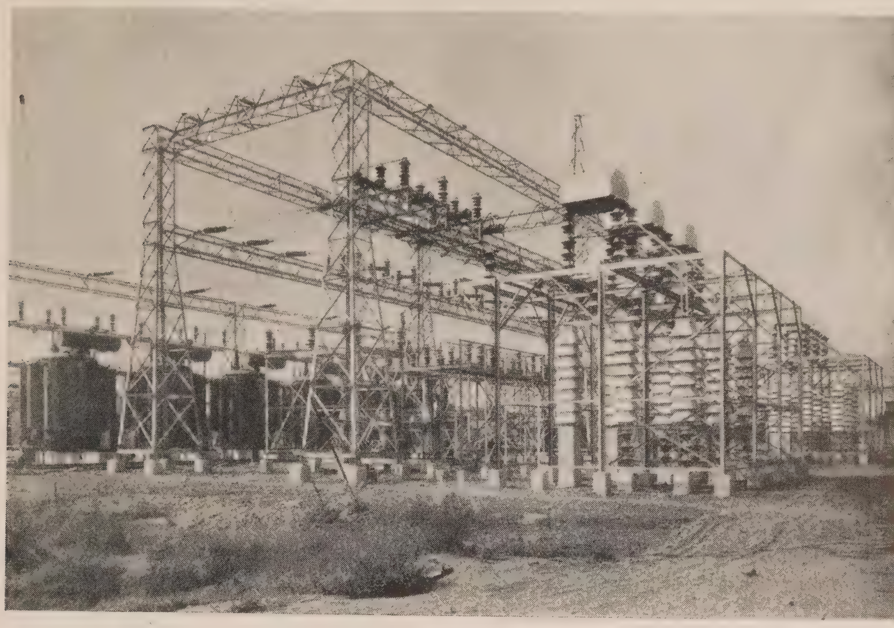
The two incoming line equipments are each equipped with one motor-operated, three-phase disconnecting switch and one 145 kv., three phase, outdoor type, oxide film arrester arranged for 73 kv. operation.

The 110 kv. main bus, as installed, forms part of a ring bus system when four banks of power transformers are installed. The equipment for same includes three three-pole single throw disconnecting switches (one motor-operated and two hand-operated) and two 110 kv. outdoor type, oil breakers.

The two banks of power transformers are connected to the high voltage bus through two motor-operated, three phase, disconnecting switches.

The above equipment, with the exception of the oil breakers, is installed on galvanized steel structures, with concrete footings, the steel being supplied by the Canadian Bridge Company.

The two 145 kv. lightning arresters were purchased from the Canadian General Electric Company, the two oil breakers are Canadian Westinghouse type "GA4" breakers which were transferred from Niagara Transformer Station, and the three phase



General view of Port Colborne Transformer Station

disconnecting switches are of H.E.P.C. manufacture, the motor-operated ones being equipped with the Shalcross Company motor mechanisms.

Transformer Equipment

The rating of the seven power transformers is 5,000 kv-a., 63.5/26.4-13.2 kv., 25 cycles, single phase, oil-insulated, self-cooled, and outdoor type with provision for air cooling blowers, and were purchased from the Canadian General Electric Company.

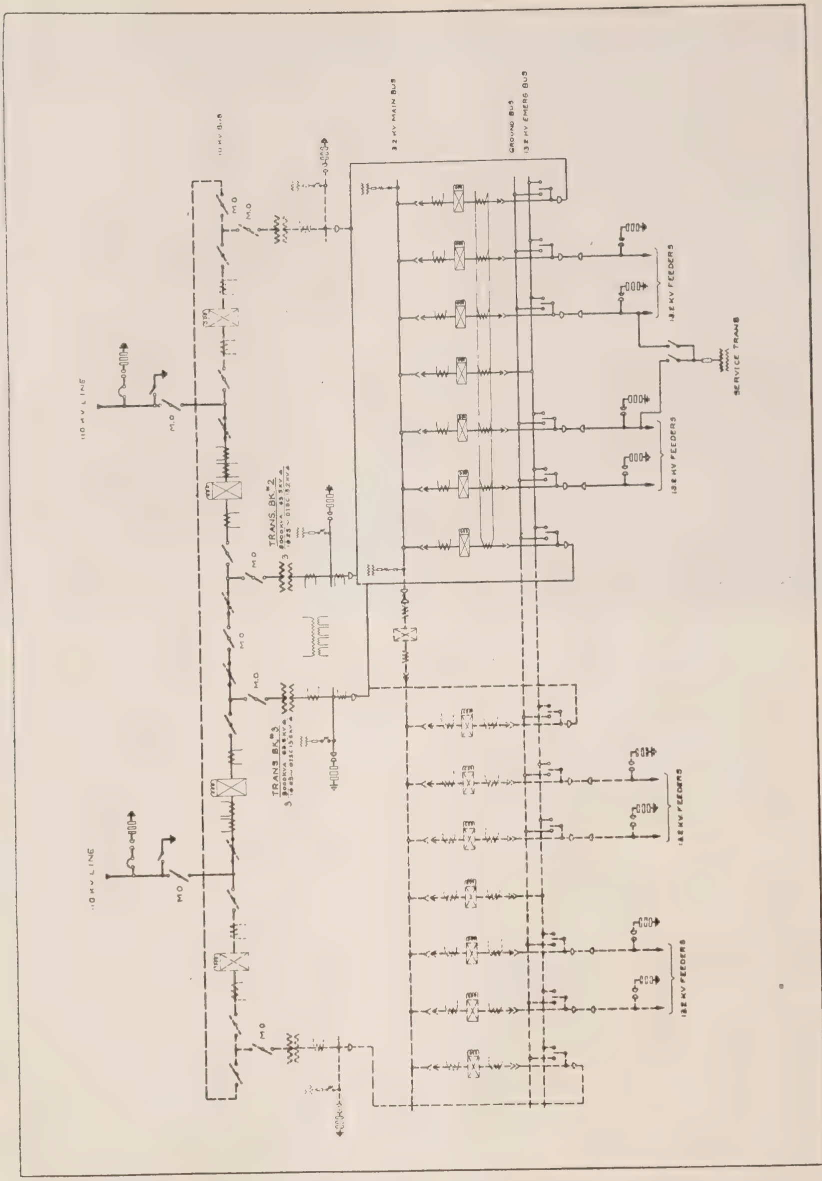
13.2 kv. Switching Equipment

The delta busses for the two banks of transformers are of standard outdoor design with 26.4 kv. insulation and spacings with a set of two 13,200/110 volt potential transformers (for metering equipment) connected to each bus.

The feeder switching equipment consists of seven feeder units of outdoor type, metal-clad switchgear to control two transformer feeders, one emergency feeder and four outgoing feeders, also two potential transformer units. As the name implies, this equipment is constructed with all the feeder apparatus, busses and connections for same enclosed in metal and isolated for safer operation.

Each feeder unit consists of a metal weather-proof housing in which is installed two sets of busses (main and emergency), one oil breaker and one three-pole, double throw, oil-insulated disconnecting switch, potheads and all copper connections between the busses and the potheads to form a complete feeder equipment.

The busses and all straight copper connections from same are insulated with 3/16 in. baked micarta insulation



Wiring Diagram, Port Colborne Transformer Station

and embedded in insulating gum in the bus compartment. The oil breakers are of the "CH-3" type electrically and automatically operated only from the switchboard and are equipped with separate motor operated devices for raising and lowering the oil breakers in the units operated from the switchboard in general operation and from the structure for maintenance and repairs. The oil breakers are connected to or disconnected from the busses and feeder connections by means of six truck type contacts, one mounted on the top end of each of the oil breaker

bushings and a set of six stationary contacts by the raising or lowering of the oil breakers. The three pole, double throw, disconnecting oil switches are hand operated and are arranged to connect the feeder cables to either the emergency bus or to ground the cables when the feeders are out of service.

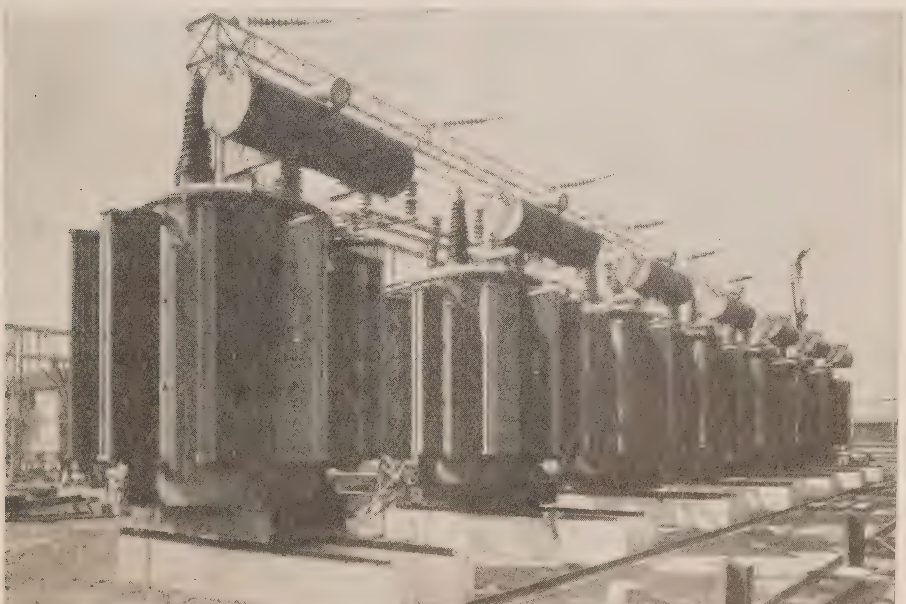
The two potential transformer units included with metal-clad equipment are for operating the relay equipment, and each consists of three 13,200/110-110 volt potential transformers with "S & C" primary fuses and truck type contacts for disconnecting same from the busses.

Limit switches and interlocking devices are installed to prevent (a) the oil breakers from being raised or lowered when the oil breaker contacts are closed, (b) the oil breaker from being closed when the disconnecting switch is in the ground position. Signal lights on the switchboard indicate the positions of the disconnecting switches and the oil breakers both physically and electrically.

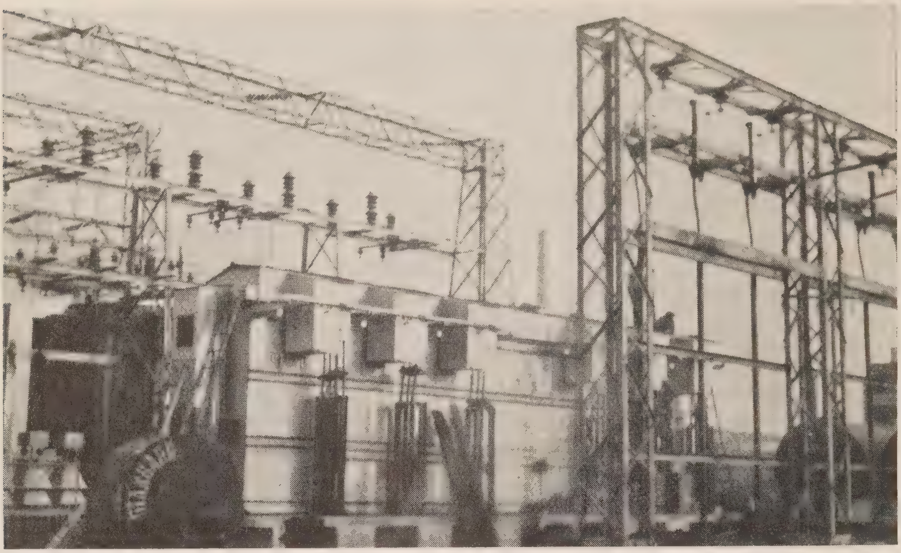
All 13.2 kv. cable connections from the metal-clad switchgear to the delta busses and the outgoing feeder structure are of single conductor 800,000 cir. mils., P.I.L.C., 13,200 volt cables, with single conductor, outdoor potheads.

For lightning protection, a 15,000 volt, three phase, station type, oxide film arrester is connected to the delta bus for each transformer bank and a set of three 15,000 volt, single phase, pellet type arresters per feeder is connected to each of the lines on the outgoing feeder steel structure.

The 15 kv. lightning arrester equipment was purchased from the Canadian General Electric Company, the



Outdoor, 5,000 kv-a., 63.5/26.4-13.2 kv., Self-Cooled Transformers



View showing metal weather-proof housing for 13.2 kv. buses and switching

15 kv. metal-clad switchgear from the Canadian Westinghouse Company, the power and control cables from the Standard Underground Cable Company and the potheads from Powerlite Devices Ltd.

Control Conduit and Cables

The concrete conduit line with three manholes was constructed to carry the control cables to the high and low voltage equipment, only the short conduit runs from the line to the apparatus being installed without concrete. The conduits for the low voltage equipment in the metal-clad switchgear were supported by the footings constructed for the switchgear. This was considered necessary on account of the wet nature of the soil.

Service Equipment

The service equipment consists of two Moloney Electric Company, 25 kw., 13,200/110-220 volt, single phase outdoor type transformers with H.E.P.C. protective equipment, one Exide 60 cell, type "EOGO-9" sealed type battery and a diverter pole motor generator set complete with all connections for lighting, heating and oil filtering systems and for the operation of the oil circuit breakers.

Metering and Relay Equipment

The metering equipment, installed, includes the installation of ammeters only on the outgoing low voltage feeders, ammeters, voltmeters, indicating wattmeters and watthour meters on the transformer banks and totalizing graphic recording meters to measure the total station load. These meters were obtained from the Canadian Westinghouse Company and Powerlite Devices Ltd.

Modern relay protection, installed to cover the complete protection of the station, includes the following: (a) reverse power relay protection on

the two incoming high voltage lines, (b) transformer zone differential and sensitive protection, (c) transformer standby protection, (d) low voltage bus differential protection, and (e) outgoing feeder distance relay protection. Relays were obtained from the Cansfield Electrical Works and the Canadian Westinghouse Company.

Steel Structures and Buildings

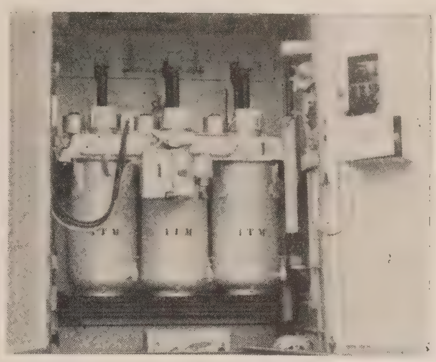
Galvanized steel structures were supplied and erected on which were installed (a) the high voltage switching equipment with exception of the oil breakers and arresters, (b) the low voltage Delta busses for the power transformers, and (c) the protective equipment of the service transformers

The high voltage oil breakers, the power transformers and the low voltage metal-clad switchgear were installed on concrete footings. A track runway, a spare transformer pocket and a transfer truck have been provided for quickly replacing a defective power transformer with the spare transformer.

The control building is a one-storey brick building 42 ft. 6 in., by 27 ft. 6 in., by 16 ft. high, divided into five rooms for control equipment, battery, oil filtering equipment, storage and wash rooms.

Oil System

The standard oil filtering and treating system, consisting of two 4,500 gallon tanks and a motor-



13.2 kv. oil circuit breaker

operated 30 gallon oil filter with the necessary piping system, was installed to handle the oil of the power transformers and oil breakers.

Fence and Grading

The site has been graded and covered with crushed stone under and around the structures, the balance being sodded.

A standard six-foot chain link fence with suitable gates has also been erected around the site.

Construction

The Commission's Construction Department has carried out all work in the construction of this station.

The construction of the station started in April, 1930. The station was placed in service on October 21st, 1930, and will be completed early in 1931. Although the high voltage equipment is all of 110,000 volt rating, the station is being supplied initially at 60,000 volts.

A Few Operating Characteristics of Domestic Motors, Radio Sets and Neon Signs

By A. W. Murdock, Asst. Engineer, Municipal Engineering Dept., H.E.P.C. of Ont.

(Presented to Association of Municipal Electrical Utilities at Toronto, January 9, 1931)

THE subject as allotted covers rather a wide field and includes three more or less separate and distinct items, any one of which might quite readily constitute a paper in itself. I have, therefore, treated them separately and attempted to analyze the characteristics from two angles, namely, the effect of the equipment on the distribution system, and the effect of irregularities in the system on the equipment.

DOMESTIC MOTORS

The number of motorized domestic appliances has reached a very substantial figure during the last few years, but perhaps many of us feel that the individual rating is so small, and the diversity so great, that the resultant load is practically negligible, especially in view of the large number of cooking and heating appliances in use. Considered only on a wattage basis, this is possibly true, but some of the characteristics peculiar to this type of equipment are rather startling and worthy of further consideration from the standpoint of both the consumer and the supply company.

There are three general types of fractional horse-power motors in domestic use; namely, the repulsion induction, split phase and universal or series motor. The repulsion induction motor is characterized by high starting torque, ranging from two to five times full load torque, and with maximum starting current of perhaps 2½ or 3 times full load current. The high starting torque brings the motor up to speed quickly and minimizes line disturbances, thus making it particularly applicable for service on oil burners, blowers and refrigerators, where heavier duty is encountered and where frequent starting is necessary.

The split phase motor, on the other hand, develops starting torque of only 100 to 150 per cent. full load torque, and draws very high starting current, which in many cases may be as great as eight or nine times full load current. Due to these inherent characteristics, split phase motors are usually only built in sizes up to ¼ h.p., and are only suitable for operating washing machines, fans and other equipment where starting conditions are light.

The universal or series motor has characteristics similar to those of the direct current series motor and its chief use in the domestic field is for vacuum cleaners and other very small direct-connected or gear-driven appliances.

The efficiency and power factor of fractional horsepower motors are low and these features, coupled with exceptionally high starting current in the case of the split phase motor,

brought about a demand for improved performance standards with the result that the following minimums have been embodied in the specifications recently adopted by the National Electrical Manufacturers Association for short-hour duty motors :

Horsepower rating................	1/8	1/6	1/4	1/3	1/2	3/4
Minimum power factor, per cent....	50	52	56	58	60	62
Minimum efficiency, per cent.......	41	46	51	54	58	61
Maximum starting current, amps...	15	15	15	15	20	20

For long-hour duty motors (service in excess of 1,000 hours per year) the minima are slightly higher for power factor and substantially higher for efficiency.

These specifications represent present-day minima, but in view of the fact that they are based on recent improvements in design, they may reasonably be considered as depicting average conditions to be found in the majority of domestic motors in use today, and, as far as starting current is concerned, they represent a very decided improvement.

Analyzing the performance of a ¼ h.p. washing machine motor, using the above figures, we find that it is doing work equivalent to 186 watts. With an efficiency of 51 per cent., we have full load watts of 365, and with a power factor of 56 per cent., a volt ampere input of 652, which is 3½ times the rated output. The full load current at 110 volts is 6 amperes so that the limits of starting current on the ¼ h.p. motor are reduced to 2½ times full load current. The low efficiency is, of course, being absorbed by the consumer in his monthly bills, but the supply company shoulders the burden of the adverse power factor, with the result that the demand on transformer, line and station capacity is nearly doubled.

The usual guarantees regarding voltage variation are that motors will operate satisfactorily on voltages 10 per cent. above or below normal rating. Since the torque varies with the square of the voltage, it is desirable that voltage be maintained as near normal as possible, as with excessive low voltage the motor may not develop sufficient starting torque to handle its load, and if left on the line turning over at a speed insufficient to actuate the centrifugal switch or short-circuiting device, a burned-out auxiliary winding may be the result, especially in view of the fact that fuses to handle the starting current may not provide adequate protection under abnormal voltage conditions. Very high voltage, on the other hand, causes lower power factor and results in the motor heating even under light load conditions. Probably the most serious factor from the consumer's standpoint is the decided reduction in torque as a result of low voltage. The average consumer judges a motor from its ability to start and handle its load, and any apparent weakness in that respect is a source of continual trouble and annoyance, which is soon communicated to the dealer or the Hydro office.

We are forced to a realization that the fractional horsepower domestic motor does not occupy a very enviable position as far as electrical characteristics are concerned, but we

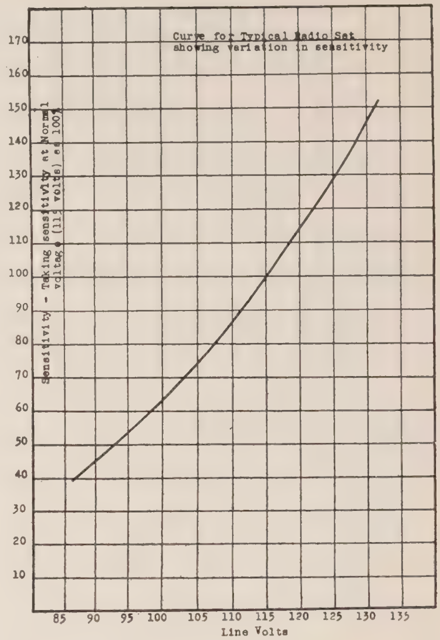
must acknowledge the recent improvements in design, and appreciate the difficulties of the manufacturer in producing a motor with lower starting current and adequate torque in the face of the demands of the appliance manufacturer that the price must be maintained.

Furthermore, we must recognize, and probably accept, the inherent limitations of the single-phase motor and see that the situation is not aggravated by poor voltage regulation, keeping in mind the fact that although the appliance motor may have many objections from an engineering standpoint, it has contributed in a very large degree to the growth and popularity of electric service throughout the country.

Radio Sets

The batteryless set on the market today has an a.c. demand of from 60 to 100 watts, depending on the size and type, and a power factor ranging from 80 to 90 per cent., governed largely by the design of the transformers and filter, as the tube filament is a straight resistance load of unity power factor. It is, therefore, quite evident that the radio receiver can have very little effect on the distribution system, in spite of the fact that there are thousands of sets in daily use.

The effect of the system on the receiver, however, is quite a different story, even apart from the interference set up by faulty equipment with which we are all more or less familiar. Voltage regulation comes into the picture immediately and plays a very important part in the sensitivity and fidelity of the set as



well as the life of the tubes and filter condensers.

The curve shown herewith illustrates the wide variation in sensitivity with a voltage range from 90 to 135. The curve is plotted with line volts against per cent. of sensitivity, assuming 100 per cent. at rated voltage of 115. We are perhaps more concerned with the portion of the curve below 100 per cent., as from the standpoint of sensitivity alone, the consumer would probably welcome the higher voltage. It will be observed that at 105 volts, the sensitivity is reduced 25 per cent. and at 95 volts nearly 50 per cent. It should also be noted that these values are typical of the higher grade set and more unfavorable results may be expected from the cheaper receivers.

The fidelity of the set, or, in other words, the quality of reproduction, is

lowered as a result of decreased voltage, but the effect is not so marked as in the case of sensitivity, as the voltage must drop to a point where tube emission is seriously affected before the fidelity is appreciably impaired.

The most serious effect of poor regulation is probably shown in the life of the tubes and, strange to say, low voltage is almost as detrimental as high voltage. The tube becomes paralyzed but does not fail physically in the same sense as the incandescent bulb. Radio tubes are designed for a definite rate of filament emission at normal voltage and if operated at a voltage below normal, the active material, which is the source of the emission, is driven off the surface of the filament and the temperature is not sufficient to replenish the supply from the interior. When subjected to excessive voltage, the active material on the surface is driven off at such a high rate that it is soon exhausted and the interior of the filament cannot supply the loss. Momentary fluctuations in voltage have very little effect as the rate of emission is not permanently altered, but when the tube is subjected to consistently high or low voltage it soon becomes inactive and its useful life is destroyed. It is practically impossible for the supply voltage to become high enough to actually burn out the filament, as evidenced in the process of rejuvenation where the tube is flashed at a voltage several times normal.

High voltage is also objectionable from the standpoint of the filter condenser which may be punctured, and although perhaps self-healing to a certain extent, the excessive voltage if maintained will produce heating and the condenser will be permanently damaged.

The manufacturer has recognized the importance of proper voltage, and has attempted to compensate for variations by the use of transformers with suitable taps, or in some cases has added a resistance regulator in an effort to take care of a 10 per cent. plus or minus variation in voltage, which is the approximate limit for satisfactory radio reception and normal tube life. The present trend, however, seems to be away from these devices, because of the increased cost and the questionable results.

Continuity of service is, of course, another very important item. An interruption in the middle of a program is very annoying, but a failure around 7 p.m. would be a calamity.

The question is often asked whether a set can be operated on either 25 or 60 cycles, and this can perhaps be answered by a casual consideration of the parts of a set to which the source of power is applied. The tubes, of course, are not affected by frequency. The 25 cycle transformer will be satisfactory on 60, and this is equally true for the filter unless it is definitely tuned for the lower frequency. The 60 cycle set connected to a 25 cycle source may be permanently damaged unless protected with proper fuses. The so called universal set is made up with 25 cycle transformers, and in some cases with a switch to alter the filter to conform with the supply frequency. Considerable care should be exercised in advising a consumer regarding the transfer of his set to a different

frequency zone, and it would undoubtedly be safer to refer him to the manufacturer or dealer.

It is quite evident that we need not be alarmed over what the radio set is going to do to us, but we should be concerned with the effect on the receiver, of a poorly designed or improperly maintained distribution system, and although the radio set may produce very little direct revenue, it is incumbent on us to see that the quality of service rendered to the consumer is of the very highest order.

NEON SIGNS

The Neon sign is simply a gas-filled glass tube, through which a high voltage current of electricity is passed, producing a luminous glow.

Neon gas was discovered by Messrs. Ramsay and Travers, English scientists, in 1898, but it was not put to practical use until several years later, when Professor Claude of France perfected a method of obtaining the gas in commercial quantities. It is of the same family as helium and argon, and is present in the atmosphere in the proportion of one part of Neon to 66,000 parts of air. It is colorless, odorless and tasteless, and is secured by means of the distillation of liquefied air. Its first successful application to sign lighting on the continent appeared in Newark, N.J., in 1909, advertising the Ingersoll watch, but the present popularity of the Neon sign dates back only a very few years. The supply of gas comes from France and Germany and is shipped in glass litre containers at atmospheric pressure, costing in the neighborhood of $24.00 per litre, which is sufficient for about 700 feet of 15 mm. tubing.

The glass used in the tubing is a high grade, specially produced for this particular application. The popular sizes are 3, 12 and 15 mm. in diameter, or approximately $\frac{1}{8}$, $\frac{1}{2}$ and $\frac{5}{8}$ ins., the $\frac{1}{2}$ in. tubing being used in the majority of signs in Ontario.

The glass tubing is formed into letters or designs, with sections averaging perhaps six to eight feet, and invariably limited to twelve feet, on account of the difficulty of producing a suitable vacuum in greater lengths. The electrodes, usually copper and in one of several patented forms, are then attached and the section evacuated. When a proper vacuum is obtained the tube is "bombarded" by the application of high voltage (usually 6,600 volts) which heats up the glass and burns out any impurities, following which the gas is admitted through an ingenious arrangement of traps and filters, and the tube is tested and sealed.

The natural color of the Neon tube is orange red, but practically any color can be obtained by the introduction of other gases combined with colored tubing. Blue is obtained from a combination of Argon and Neon, known to the trade as B10 gas, with a small quantity of mercury added to give density. This gas, when used in yellow tubing, produces a green color. The tube gives off practically no heat which accounts largely for its economy of operation. The gas does not burn up, and the tube has a life of from 15 to 20 thousand hours, although difficulties are encountered in the way of fading, due principally

to leakage with a resultant reduction in the original vacuum. Experiments are being conducted in an effort to produce a white light, and if successful, it is claimed that interior lighting will be radically changed. The natural red Neon color, having a long wave length, possesses high penetrating power which makes it especially attractive in daylight or fog, and it is being applied quite extensively to beacon lights for airports.

The tubes require an extremely high voltage, and the 110-volt supply is stepped up as high as 15,000 volts, the present day Ontario practice being confined to the use of three transformers with secondary voltages of 5, 12 and 15 thousand volts, and with respective volt-ampere ratings of 150, 350 and 450. With secondary operating current of only 25 milliamperes the signs cannot be considered as particularly dangerous, and the life and fire hazard is reduced to a minimum in Ontario due to our rigid standards, which require the sign to be constructed entirely of metal with all accessible live parts enclosed. The middle point of the secondary winding of the transformer is grounded, which reduces the voltage to ground by one-half.

The size and number of transformers to be used is determined from the length of the various sections of tubing in the sign, on the basis of the following approximate figures for ½ in. tubing operating at 25 cycles :

5,000-volt transformer 9 to 11 ft.
12,000-volt transformer, 25 to 27 ft.
15,000-volt transformer, 35 to 40 ft.

For 60 cycles the lengths may be increased by approximately 20 per cent., and increased or decreased for the ⅝ in. or ⅛ in. tubing in the direct ratio of the diameters. The loading is approximately 8 watts per foot of tubing for the ½ in. size and 6 watts for ⅝ in. A sign having a total of 160 feet of ½ in. tubing and operating at 25 cycles would require the equivalent of at least four 15,000-volt transformers, but the design of the sign, or the combination of the small 6 and 8-foot sections, might necessitate one or more additional transformers. The sections of tubing are connected in series across each individual transformer, and the various transformers are paralleled on the low voltage supply. A 25-cycle transformer with a 15,000-volt rating weighs approximately 40 lbs., and costs the sign manufacturer about $19.00.

A Neon sign is decidedly heavier than an equivalent incandescent sign, and the capital cost is perhaps double. They are invariably sold at a price computed on the total length of tubing, ranging in the neighborhood of $7.00 per foot, which covers the complete sign including transformers and erection. It is very difficult to get a definite basis of comparison as regards operation and maintenance, but it is a generally accepted fact that the cost of a Neon sign over a period of five years will be only about 25 per cent. of the cost of an incandescent sign.

The transformers used for Neon signs have an inherently high reactance with a resultant low power factor. Tests recently conducted by an American power company on 611 straight Neon signs showed total volt amperes approximately 2¼ times total watts, giving a power factor of

44 per cent. with an average loading of 642 watts per sign. On another group of 330 Neon signs containing one or more incandescent lamps the average power factor was 68 per cent. On the total of 941 signs the average power factor was 52 per cent. This naturally imposes a serious burden on the distribution system, and if billing is solely on the basis of kilowatt-hours, the consumer does not take his proper share of the cost. The regulations in Ontario call for a volt-ampere rating on the sign equivalent to the total rating of the individual transformers, so that as far as demand or installed capacity on a straight Neon sign is concerned, we are probably protected, and, even though the energy is measured in watt-hours, the apportioning on the basis of a volt-ampere demand seems reasonably fair. Where the sign is used on a joint service with store lighting, and the total load is measured with an energy demand meter, there may be some element of doubt, although it must be remembered that the watts load of the sign is comparatively small, and its poor power factor may be largely offset, particularly at the time of the consumers peak, by the heavy incandescent lamp load.

Where the sign is independent of store lighting, and the consumer is billed for demand based on a volt-ampere rating, it would certainly be to his advantage to install corrective equipment. There is a capacitor unit on the market designed for Neon sign application, but this has not yet been passed by the approvals laboratory, and at the present time in Ontario the correction would have to be taken care of by means of a static condenser installed externally to the sign.

The Neon sign may be classed as a commercial commodity with almost unlimited possibilities and the number on the system is rapidly increasing from day to day. It is a new member of our already large family of electrical equipment and appliances, and, although the power factor is not of the highest order, it can scarcely be classed as an undesirable load.

Association of Municipal Electrical Utilities

Report of Merchandising Committee

The Merchandising Committee of the A.M.E.U. held a meeting in the offices of the Hamilton Hydro-Electric System on Wednesday, December 10th.

Present: Mr. O. H. Scott, Belleville, *Chairman*, Mr. W. H. Childs, Hamilton, Mr. A. B. Manson, Stratford, Mr. F. S. Rhoads, Windsor, Mr. I. Pritchard, Chatham, Mr. F. Robinson, Stratford, Mr. A. B. Scott, Galt, Mr. H. F. Shearer, Welland, Mr. Turner, Hamilton, Mr. W. C. Dymond, H.E.P.C., Mr. G. J. Mickler, H.E.P.C.

This meeting was called to discuss problems confronting Hydro Shops and to provide a report for submission to the A.M.E.U. Convention in January.

No definite agenda was prepared beforehand so that matters for discussion were developed as the meeting proceeded.

There were several very important matters brought up and discussed and recommendations made regarding them and these are enumerated as follows :

1. *Re Hydro Shop Activity.*

It was reported that rumors are being circulated to the effect that Hydro Shops having outlived their usefulness are about ready to discontinue their efforts in the sale of electrical appliances. The source of this rumor could not be ascertained but the members of the Committee were emphatic in their opinions that Hydro Shops were more than ever necessary if electrical appliances were to be sold and placed on the Hydro lines, and that the meeting go on record as stating that Hydro Shops be encouraged to increase their activities wherever possible to give greater service to the people in the communities where they are located. From the experience of several of the members it has been found that the concensus of public opinion favours the operation of a Hydro Shop in Hydro municipalities.

2. *Hydro Advertising.*

The meeting felt that there is a general dearth of advertising among Hydro municipalities to bring before the Hydro consumers the benefits of Hydro service and electrical appliances in general and it was recommended that some effort be exerted by the A.M.E.U. to have Hydro municipalities increase their advertising effort, not only to promote the use of Hydro, but to increase the popularity of electrical appliances.

3. *Combating Gas Competition.*

It is recognized that in order to promote the sale of ranges and other large current consuming devices, especially in localities where there is active gas competition, trade-ins on old equipment frequently effect sales. Where trade-ins must be indulged in to meet this competition it is recommended that the cost of such trade-ins should be shared by the Power Department of the Utility on the

argument that there is considerable benefit accruing to the Utility in general through the retention of an electrical consumer.

4 Cost of Installation.

Figures on the cost of installing services to provide for electric ranges and other large appliances were brought before the meeting and discussed. The effect of the apparent high cost of installing services seems to be to hinder the sale of these appliances, especially where gas competition is a factor. To offset this, it is recommended that consideration be given to the policy of a local Utility bearing as a capital charge the cost of services up to the meter.

5. Direct Advertising.

The value of advertising direct to the consumer through the medium of the lighting bills was brought up and discussed, and it was found that several municipalities advertise on their lighting bills with very good results, and it was recommended that this policy of printing an advertisement either on the back or on the face of the bill be recommended for use to other municipalities operating Hydro Shops. It may be necessary to increase the size of bills to bring this about but that should be no detriment.

6. Surplus on Hydro Shop Operation.

After considerable discussion on the question of the elimination of Hydro Shop surpluses it was recommended that an effort be made to have Hydro Shop surpluses restored so that Hydro Shops can receive the benefit of their operations from year to year and so that they may be encouraged, rather than discouraged, in their efforts which at this particular time require it.

7. Cheap Appliances.

The question as to the wisdom of Hydro Shops selling cheap appliances was brought up and discussed. Recalling the policy originally outlined for the operation of Hydro Shops wherein it is stated that only electrical appliances of high quality should be marketed through Hydro channels, it was recommended that the sale of cheap appliances should be confined to only those of high quality. Cheapness does not always mean low value. The handling of cheap low grade appliances is to be discouraged.

8. Made in Canada Goods.

It was recommended that Hydro Shops be asked to confine their efforts as much as possible to the sale of Made in Canada goods.

9. Illumination Service.

The service of the H.E.P.C. Illumination Laboratory whereby lighting consumers in Hydro municipalities are enabled to receive free illumination advice was brought before the meeting and it was recommended that Hydro municipalities make use of this service as far as possible to encourage better illumination of stores, factories and offices.

10. Time Payments.

The question of down payments on installment purchases was brought up and discussed, and the concensus of opinion was that down payments on the sale of electrical appliances would have to undergo a downward revision if Hydro Shops were to maintain their place in the retail field. The

tendency in other lines of business is to sell on a low down payment and Hydro Shops are suffering to some extent on this account.

As this question is one which will be thoroughly discussed in a separate paper at the Convention, and as this paper may effect the general policy of installment sales, no definite recommendation was made regarding the minimum or maximum percentages to be secured as down payments.

O. H. SCOTT,
Chairman.

* * * *

REPORT OF COMMITTEE ON ACCIDENT PREVENTION AND HEALTH PROMOTION

At the Convention of the A.M.E.U. held in Toronto on January 29th and 30th, 1930, the Committee on Accident Prevention and Health Promotion presented a report primarily dealing with Overhead Construction. This report was received, and it was felt that time should be given for the study of it before its adoption. Copy of the report in detail appeared in the H.E.P.C. Bulletin and further copies of the report were forwarded by letter to a number of the larger municipalities, requesting discussion.

As far as the Committee is aware, the only criticisms received in connection with the report were that the report should also include other matters in regard to the prevention of accidents, which criticisms the committee thoroughly agrees with, but feels that the basic principles as laid down in the report are adopted and future committees could then extend the policy as laid down, with particular reference to enlarging the matter dealing with specifications of safety devices and of the testing of such devices.

One matter in connection with the report which the committee would recommend be amended is the matter of physical examination of linemen. As the report now reads physical examination is required in Class "A" linemen, and is made optional before a man enters the class of Class "B" linemen; the committee's feeling is that such physical examination should be at the time of a man entering the work as a Class "C" lineman. In view of the discussions of the matter by the committee, the thorough presentation of the matter to the membership and ample opportunity and time for discussion, it is moved: "That the report of this committee as presented at the Convention held in Toronto on January 29th and 30th, 1930, with amendment in regard to physical examination, be approved."

CHAS T. BARNES,
Chairman.

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AUDITORS' REPORT

Statement of Receipts and Disbursements and Assets for year ending December 31, 1930.

RECEIPTS

Cash in Bank, Dec. 31, 1929		$1,664.89
Membership fees :		
Utilities	$1,342.00	
Commercial	400.00	
		1,742.00
Convention receipts		2,219.00
O.M.E.A. Contribution		452.91
Interest on deposits		54.67
Interest on Bonds		27.50
		$6,160.97

DISBURSEMENTS

Convention Expenses :		
Dinners and Luncheons	$2,007.00	
Entertainment	573.53	
Printing	272.25	
Reporting	197.85	
Badges	196.99	
Sundry Expenses	60.21	
		$3,307.83
Travelling Expenses		366.75
Remuneration Secretary and Treasurer		250.00
General printing		84.50
Postage		40.21
Bank Exchange		23.90
Province of Ontario bond		1,046.20
Balance		1,041.58
		$6,160.97

ASSETS

Balance at Bank		$1,041.58
Prov. of Ontario 5½% 1934 bond, par value $500		513.50
Prov. of Ontario 5% 1948 bond, par value $1000		1,042.25
Projecting Machine	$243.45	
Less depreciation	143.45	
		100.00
		$2,697.33

To the President of A.M.E.U. :

We have examined the above statement of Receipts and Disbursements with the books of the A.M.E.U., and it is, in our opinion, properly drawn up so as to represent the Cash transactions of the Association during the year, and the Assets disclose the true condition of affairs as at December 31st, 1930.

(Sgd.) W. G. PIERDON,
H. P. L. HILLMAN,
Auditors.

MINUTES OF EXECUTIVE COMMITTEE MEETING

A meeting of the 1931 Executive Committee of the Association of Municipal Electrical Utilities was held at the Royal York Hotel, Toronto, on the evening of Thursday, January 8th, 1931. The meeting was called to order by the President, J. W. Peart, at 7.00 o'clock. Others present were:—Messrs. T. W. Brackinreid, R. S. Reynolds, C. E. Schwenger, T. J. Hannigan, E. V. Buchanan, H. T. Macdonald, O. H. Scott, J. E. B. Phelps, R. L. Dobbin, C. A. Walters, G. E. Chase, and S. R. A. Clement.

The election of officers during the afternoon having resulted in a tie for District Director, Central District, between G. E. Chase and C. A. Walters, the contestants asked that the election be decided by the tossing of a coin. This was done and C. A. Walters was declared elected.

Letters were read asking for the consideration of Windsor, Montreal and Ottawa as the meeting place for the next Summer Convention. A telegram from Mr. R. V. Slavin, Winnipeg Hydro, was read. This advised that Mr. Slavin could not be present to discuss the question of the Association admitting utilities outside Ontario, and asked to be advised of the next meeting.

Mr. C. M. Robertson, Manager, Tourist and Convention Bureau, Canadian National Railways, attended to advise regarding the Chateau Laurier, Ottawa, for the Summer Convention. After an extended discussion of the proposition presented by Mr. Robertson it was moved by

Mr. T. J. Hannigan and seconded by Mr. J. E. B. Phelps:

"THAT the Summer Convention be held at the Chateau Laurier, Ottawa, provided that the Canadian National Railways assure us we can get single rooms with bath at $4.00 per day and double rooms with bath at $8.00 per day, the Convention to be held on June 25, 26 and 27, 1931".—*Carried.*

Mr. Robertson promised to communicate with Montreal and give his reply on the following morning. (The reply received was that the rate for single rooms would be $4.50 per day and $8.00 per day for double rooms. Mr. Robertson was advised that this was acceptable.)

Standing Committees for the year 1931 were then drafted as follows :

Papers Committee:—E. V. Buchanan, London, Chairman; T. R. C. Flint, Toronto; Joseph Showalter, Canadian Westinghouse, Toronto; M. J. McHenry, Canadian General Electric, Toronto, and A. G. Lang and J. J. Jeffery, H.E.P.C. of Ontario, Toronto.

Convention Committee : — C. E. Schwenger, Toronto, Chairman : R. H. Starr, Orillia; D. B. McColl, Walkerville; V. A. McKillop, London; F. Mahoney, Canadian General Electric, Toronto; H. T. Gibbs, Canadian Westinghouse, Toronto; C. H. Hopper, Ferranti Electric, Toronto, and J. N. Wilson, E. R. Lawler and J. W. Purcell, H.E.P.C. of Ontario, Toronto.

Regulations and Standards Committee:—C. A. Walters, Napanee, Chairman; H. F. Shearer, Welland; J. E. Teckoe, Niagara Falls; V. S. McIntyre, Kitchener; W. J. Jackson, London; R. J. Smith, Perth; W. E. Wallace, Windsor; F. W. Peasnell, Toronto; A. G. Hall, Electrical Inspection Department, Toronto, and W. P. Dobson, H.E.P.C. of Ontario, Toronto.

Committee on Accident Prevention and Health Promotion:—R. S. Reynolds, Chatham, Chairman; H. G. Hall, Ingersoll; W. E. Reesor, Lindsay; C. E. Brown, Meaford; C. E. Schwenger, Toronto; V. A. McKillop, London; F. D. Hubbell, Windsor, and T. C. James, G. F. Drewry, E. R. Lawler and Wills Maclachlan, H.E.P.C. of Ontario, Toronto.

Merchandising Committee:—O. H. Scott, Belleville, Chairman; J. E. B. Phelps, Sarnia; F. S. Rhoads, Windsor; A. O. Hunt, London; W. H. Childs, Hamilton; C. W. Burns, Walkerville; I. N. Pritchard, Chatham; A. B. Scott, Galt; R. S. King, Midland; J. J. Heeg, Guelph; A. B. Manson, Stratford; H. F. Shearer, Welland; A. W. J. Stewart, Toronto; R. J. Smith, Perth, and G. J. Mickler, H.E.P.C. of Ontario, Toronto.

Rates Committee:—J. E. B. Phelps, Sarnia, Chairman; P. B. Yates, St. Catharines; E. I. Sifton, Hamilton; E. M. Ashworth, Toronto; A. B. Manson, Stratford; V. S. McIntyre, Kitchener; J. G. Archibald, Woodstock; A. B. Scott, Galt; O. M. Perry Windsor; D. B. McColl, Walkerville, and all of the members of the 1931 Executive Committee.

Committee on Accounting and Office Administration : — R. L. Dobbin, Peterborough, Chairman; D. B. McColl, Walkerville; W. H. Childs, Hamilton; A. B. Manson, Stratford; I. N. Pritchard, Chatham; W. E Wallace, Windsor; R. S. King, Midland; H. Clegg, Peterborough;

A. L. Farquharson, Brockville; Geo. Appleton, Toronto, and G. F. Drewry and R. M. Bond, H.E.P.C. of Ontario, Toronto.

Auditors :— H. P. L. Hillman, Toronto, and W. G. Pierdon, H.E.P.C. of Ontario, Toronto.

It was moved by Mr. T. W. Brackinreid and seconded by Mr. C. E. Schwenger:

"THAT the Committees as drafted be the Standing Committees for 1931."—*Carried.*

It was moved by Mr. O. H. Scott and seconded by Mr. T. W. Brackinreid.

"THAT the Treasurer be instructed to pay the Secretary an honorarium of $150.00 and the retiring Treasurer $125.00."—*Carried.*

Mr. R. L. Dobbin, retiring President, gave a short address thanking the 1930 Executive Committee for the assistance given by its members in making that year a successful one for the Association and extending good wishes for continued efforts for 1931. The President elect, J. W. Peart, then made a brief reply.

The meeting adjourned at 8.15 o'clock.

Seriousness of Low Voltage Hazards

CONTACT with the so-called "low voltage" electric current, carrying charges of from 110 to 750 volts, is always dangerous and under certain conditions, fatal. There have been more than 100 such cases which have resulted fatally in the United States and Canada during the past two years.

This is a small number, of course, compared with accidental deaths in other fields, yet it brings out the fact that the dangers of low voltage are quite generally underestimated.

For the past year a special committee of the American Society of Safety Engineers—Engineering Section, National Safety Council, has been studying low voltage hazards and the peculiar circumstances surrounding the cases which have come to its attention. The progress report which has just recently been completed reveals some interesting facts:

BATHTUB FATALITIES LEAD IN HOME

Forty-four or more than two-fifths of 107 cases studied were caused by ordinary 110 alternating current voltage.

There were 58 purely industrial fatalities in the group, nine mine fatalities and four railroad tragedies. Home fatalities rank second to industry with 31 deaths. Bathtub fatalities led the domestic list with 12 deaths. Next in importance came fatalities from contact while on wet basements or earth, with seven fatalities. Portable appliances came next in the home with six tragedies and amateur experiments caused one fatality. There were several instances where the victims were working under cellarless houses with portable electric lamps.

If the study of the domestic group can be taken as fair cross-section of experience it is evident that the

bathtub cases occur nearly twice as often as other electric tragedies in the home.

Most of the bathtub cases involved the use of electric heaters on which the insulation of the connecting cord was defective or was handled with wet hands. In one case the curling iron provided the contact with the circuit. The domestic cases also included two fatalities from electricity occurring while the victim was in bed. In one of these an electric heater set fire to the bed clothes and in the other a man was found dead wearing an electric blanket, the death evidently occurring while he was wet with perspiration. All of the domestic fatalities occurred at approximately 110 volts.

Defective Materials Responsible

In securing data for the committee the National Safety Council and the National Electric Light Association each conducted separate inquiries into the cases available. The latter organization found that 45 of the 106 cases studied involved the use of defective materials. Thirteen of the deaths were due to handling exposed wires; 11 fatalities resulted from working or handling live parts and there were six flagrant violations of the National Electrical Code.

That the exposed switch is becoming a thing of the past is shown by the fact that only one fatality was recorded against this hazard.

The report shows that at least one-third of the fatalities may be attributed to defective materials such as the lamp cord not properly maintained. Five to twelve per cent. are due to installations not in accordance with standard practices as represented by the National Electric Code. Ten to fifteen per cent. are due to handling live parts and about 8 per cent. more to improper practices from which are excluded the ignorant handling of radio aerials and a few disastrous amateur experiments.

The report emphasizes the necessity of using proper types of extension cords and the careful maintenance of such cords and all other electrical equipment. The use of weather-proof sockets is also urged as is also the proper grounding of portable devices of all kinds when used in damp locations. The report discourages the use of portable appliances in the bathroom and urges the practice of killing circuits at all times before attempting to work on them.

Representatives of nine organizations prepared the report.

—*Public Safety.*

ILLUMINATED FOUNTAIN AT BARCELONA

The fountain at the Barcelona Exhibition is described by Mr. A. S. E. Ackermann, B.Sc., F.C.G.I., in the Transactions of the Society of Engineers. It is the world's largest and most exquisite illuminated fountain of nearly 2,000 jets of milk-white water which, beautiful in themselves, are, in addition, illuminated by many different coloured lights. The patterns formed by the jets slowly change; now the centre is tall and slender with a surrounding ring of graceful inward curving feathers; now the outer ring throws an outward arch, while the centre group is like a lovely sheaf of wheat. Then there

arise many groups of smaller fountains and now rings of cascades: and so on, until forty different graceful patterns have been formed, while all the while the different designs are illuminated by many changing groups of colours from invisible sources. So skilfully is this done that the fountain simply glows with soft coloured lights of many hues. One exquisite effect is produced by surrounding the central group of jets by a tube of golden light, which is invisible until the spray from the jets falls into the surrounding coloured light. The resulting effect is as if fine glittering gold were being showered down.

The outer ring of the 1,700 jets is 125 feet in diameter and some of the jets are 160 feet high. The lighting is done from below the basin into which all the water falls. There are seven hundred and fifty 2,500 candlepower incandescent lamps (besides arc lamps) arranged in groups of eight, and around each group is a pentagonal frame carrying different coloured glass—red, green, yellow, blue and white. The frames are rotated electrically from time to time to change the colours.

The water is forced through the jets by electrically-driven centrifugal pumps of 1,700 horsepower and the quantity of water discharged by the jets is two million gallons per hour, while the combined effect of all the lights is nearly two and a half million candlepower. So great is the heat given off by these lamps that over five million cubic feet of air per hour have to be forced past them to keep the space beneath the basin cool enough for the men at work there.

The whole of the jets and coloured lights are electrically controlled from a cabin at such a distance from the fountain that the whole of it can be seen. The alteration of the patterns formed by the jets, and their colouring, is done by one man manipulating the 945 small levers forming a keyboard.

The cost of the fountain was about £200,000, and the following are the leading technical data:—

Total power of the installation—4,000 kv-a.

Total power in the pumps—1,700 h.p.

18 motors for auxiliary hydraulic apparatus—150 h.p.

Total power of the motors for operating the illuminating plant—200 h.p.

Capacity of the pumps—9,360 c. metres per hour.

Maximum height of jets—50 m.

Number of automatic valves from 250 to 500 mm. diam.—140.

Number of jets—1,700.

Number of combinations or patterns formed by the jets—40.

Number of ventilation fans for cooling the chamber containing the plant and lights—3.

Quantity of air delivered by above fans at a water gauge pressure of 50 m.m.—151,000 c. metres per hr.

Total power of the lights,—2,400,000 candlepower.

—*The Overseas Engineer.*

Hydro News Items

Eastern System

The municipality of Deseronto passed the necessary by-laws for the purchase of the local distribution system on January 5th, 1931.

* * * *

The municipality of Tweed passed the necessary by-laws for the purchase of the local distribution system on December 29th, 1930.

* * * *

Water shortage on the Madawaska River compelled the Commission to make temporary connections between the Madawaska system and the Gatineau Power Company. This was accomplished by the temporary use of one of the 220 kv. lines from Paugan to Leaside.

* * * *

Niagara System

The Board of Water Commissioners of the City of Niagara Falls are erecting a new waterworks plant in the Village of Chippawa where the city water supply will be obtained from the Niagara River via the Chippawa creek or the Chippawa-Queenston power canal.

The new station, which is known as the Niagara Falls filtration plant, was designed by H. G. Acres & Company, and will be equipped with the necessary apparatus for treating and filtering the river water after which it will be pumped to the city mains.

From the Commission's lines, 12,000-volt power will be obtained stepped down through three 650 kv-a. transformers to 2,200 volts for high and low pressure pumps and to 110-220 volts for sump pumps, motor generating sets, lighting, etc. There will be three high pressure pumps driven by a 500-h.p., a 450-h.p., and a 200-h.p. induction motor respectively with provision in the wiring for three 500-h.p. motors if required. The low pressure equipment will be driven by two 75-h.p. and one 40-h.p induction motors, all at 2,200 volts. A 20-h.p., 220-volt motor on the sump pump and a 5-h.p. motor on the alum pump complete the motor equipment. These latter are supplied through three 25 kv-a. transformers, while the lighting circuits are supplied through a 25 kv-a. transformer.

All 2,200-volt motors are supplied from one bus and are started from another connected to the first through auto transformers.

The metering will be on the 12,000-volt side of the transformers and the station will be controlled by an oil breaker having a rupturing capacity in excess of 750,000 kv-a.

Those interested in modern waterworks equipment should visit this plant which is situated close to the river road on the north side of the Village of Chippawa.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

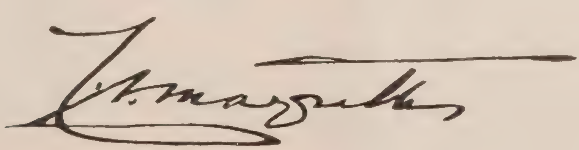
To — Mr. Gaby, The Staff and Other Employees of "Hydro"

I have been so happy with you all that I find it a very great wrench retiring from Hydro. While many of you have seen little of me, I hope you will appreciate that I have always been interested in your welfare.

In the conduct of your work, widely scattered throughout this Province, you are certainly doing your share to establish this great organization. Integrity is the bedrock of a lasting business.

The moulding of a great business so as to play its proper part in the development of the resources of Ontario is something that takes time. You have your full share of that responsibility; and may I add that the Commission has always been appreciative of your efforts.

My interest in you all will continue to the end.



Ontario's Future Power Supplies Assured

By F. A. Gaby, Chief Engineer, H.E.P.C. of Ont.

The following statement outlines the general policy which has been followed by the Hydro-Electric Power Commission of Ontario in order to provide for the present and future needs of the citizens of the Province in the matter of electrical service. It is issued to show that the general program to provide a power load capacity equal to the present and potential demand is entirely justified, and not only could not be called over-development, but is in danger of not being sufficient if the available water power sites are not developed within the next few years. The statement was intended to give the views and experience of Hydro Executive and Consulting engineers regarding the future power needs of the Province and the manner in which the Commission is attempting to meet these needs.

For and on behalf of the executive heads of departments of the Hydro-Electric Power Commission of Ontario, I give the following memorandum which speaks for itself. This is prepared in order to show that the general program adopted for the provision of future power supplies is a sound policy which can be justified from past experience in order to protect industry when such expansion as is expected to accompany the return to normal economic conditions occurs.

— *F. A. Gaby.*

LEADERS in the development and utilization of Canada's natural resources appreciate the vital necessity for large supplies of electrical power. During recent years, unprecedented supplies of hydro-electrical power have been provided for industrial expansion in Canada. In the past decade hydro-electric installations have increased by 140 per cent., from 2,515,000 horsepower to 6,125,000 horsepower; of this increase 1,787,000 horsepower has been developed during the last five years.

OUTSTANDING ITEMS IN CANADA'S RECENT GROWTH

Item	Unit	1929 Data	Percentage Increase Over 1911
Population	Number	9,797,000	36
Wheat Production	Bushels	299,000,000	126
Forest Products, Exports	Value	$ 288,000,000	414
Gold Production		$ 39,800,000	306
Nickel Production	Pounds	110,000,000	224
Manufactured Products	Net value	$1,810,000,000*	222
Exports of Domestic Merchandise	Value	$1,364,000,000	397
Mileage of steam railways		41,300	63

* 1928.

Statistical records of Canada's Census Bureau show that since electrical power has been extensively available there has been very marked progress in the development of Canada's forest, mineral, agricultural and other resources, and especially in their fabrication into the finished products of industry. This development cannot be furthered without the provision of adequate supplies of power.

Since the 1911 census year, the preceeding items of economic development are recorded.

Such figures are representative of the growth in development of prominent Canadian activities.

An outstanding feature of Canadian growth in recent years is the relatively rapid increase in economic activities as compared with the increase in population. The factors which have in the years just past tended to restrain immigration and retard population growth cannot be expected to operate to a similar extent in the future. Among the countries of the world, Canada is characterized by basic conditions such as usually attract both an extensive immigration and the additional capital needed to give employment to the enlarged population.

Such industrial and commercial progress as has taken place in the past has accompanied and demanded the provision of ample power supplies. The prospect for the future absorption of power supplies points to the necessity of providing for growth, not only on the scale of the past but on an accelerated scale commensurate with the probable more rapid future increase in population.

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Stated in brief, the considerations which generally determine the policy of those responsible for the provision of electrical service are as follows :

First:—Extensive and rich natural resources in forest, mineral, and agricultural wealth cannot be turned to advantage in satisfactory industrial development and economic growth apart from the utilization of low-cost electric power.

Second:—Water power has constituted in general the best source from which electrical service can be provided for Canada. Its utilization, especially in those areas deficient in native fuel supplies, decreases dependence of the country upon outside fuel resources. It is a noteworthy fact that in Canada more than 97 per cent. of the central station output of electrical energy is derived from water-power development.

Third:—Large supplies of hydro-electrical energy cannot be made available on short notice. Ordinary large developments require from two to four years to plan and complete. In the case of the St. Lawrence river development, due to the magnitude

of the works, it will take from five to eight years, after all difficulties involving private, national and international interests have been removed and the undertaking is actually commenced, before power can be supplied. Those entrusted with the work of providing for the power needs of the future cannot defer action until demands materialize. Future power requirements must be anticipated and their extent, as closely as possible, evaluated.

Fourth:—It is usual in all power developments to provide some surplus power for exceptional needs or as insurance against unforseen contingencies. The lack of surplus power can be a serious handicap. During the last year in the city of Winnipeg and adjacent territory, in British Columbia and certain districts in Ontario, a serious power shortage, resulting from exceptional meteorological conditions, caused serious inconvenience.

Fifth:—The growth in demand for electrical energy over a period of years is influenced by a number of factors, many of which are largely independent of the cyclical phenomena of prosperity and depression. Factors in this increase are: the inevitable steady growth in population, occasioning erection of new buildings; the growth in popularity and use of domestic electrical appliances; the increasing appreciation on the part of commercial establishments of the value of superior lighting; the adaptation of electrical power to new and improved uses in existing manufacturing industries; and the general increase in wealth of the country, reflected in an increased ability to purchase commodities and service which in turn require for their production additional energy. Thus, even in times of general business depression there is an increasing electrical demand which may be attributed to the very diversified character of the service rendered.

Now, having in mind the above considerations, it may be added that with respect to the rate of growth in demand for electrical service which accompanies growth in economic activities, there is available an experience extending over 25 to 30 years, and included within this period are various years of pronounced business depression. Statistical records for this period reflect experiences both in Canada and in the United States.

Turning then to authoritative data from federal government sources with respect to hydraulic turbine installation in Canada, to electrical energy generated by central stations in Canada, and to the electrical energy generated by public utility power plants in the United States, we find the following very striking facts:

(A) *Waterpower Installation in Canada:* Since 1919 there has never been a year recorded in which an installation 50 per cent. greater than the then existing installation has not been required within six years — in many instances in four years or less. The average five-year increase over the last twenty years was 58 per cent., and for the period 1920–1930, the average five-year increase was 56 per cent.

(B) *Kilowatt-hours Generated by Canadian Central Electric Stations:* Since 1920, there has never been a year recorded in which an output 50

per cent. greater than the then existing output has not been required within four years — in several cases in three years or less. The average four-year increase for the period 1919–1929 — which covers the whole period for which adequate statistics are available — was 61 per cent., and for the period 1922–1929, the average four-year increase was 75 per cent., and the average three-year increase, 52 per cent.

(C) *Kilowatt-hours Generated by United States Public Utility Power Plants:* Since 1918, there has never been a year recorded in which an output 50 per cent. greater than the then existing output has not been required within five years — in several cases, in four years or less. The average five-year increase for the period 1902–1929 — which covers the whole period for which adequate statistics are available — was 74 per cent., and for the period 1919–1929, the average five-year increase was 58 per cent.

Now, the direct bearing of these experiences upon the program of hydro-electric development is this: At the present time the total hydro-electric development in Canada aggregates approximately 6,125,000 horsepower. The developments under actual construction total 1,700,000 horsepower and will soon reach 2,000,000, an increase of about 30 per cent., —a figure which in the light of past records may be considered quite conservative.

Now, referring specifically to the work of the Hydro-Electric Power Commission, it may be stated that Ontario's available economic water powers, other than small power sites situated at widely-separated places, are the international and inter-provincial powers which exist on the Niagara, St. Lawrence and Ottawa Rivers. Before further development of these can proceed, international, inter-provincial and other interests will have to be adjusted and co-ordinated.

Hydro-electric developments of to-day require ordinarily from two to five years to complete. An important factor in the amount of time required is the necessity — nearly always characteristic of hydro-electric development — of constructing at the time the initial development is made, a large proportion of the permanent works for the utilization of the ultimate capacity of the site. In the case of the St. Lawrence, in view of the magnitude of the work, no power can be produced from such developments at an earlier date than about five years and perhaps later, depending upon the character of the work.

In the case of the Commission's operations, the load now aggregates 1,260,000 horsepower. The provision made for the development and purchase of power for the more immediate future will, as the various developments are completed, bring this total up to over 1,900,000 horsepower. This is an increase of 50 per cent. over present use which, from past experiences, is a wise provision for the future, especially in view of the fact that certain portions of this power cannot be delivered before the expiration of five years.

On the basis of past experience, it would appear that the provision above outlined will take care of about five years of future demand, possibly

but four years. Furthermore, if no additional provisions for power are made and it takes, say, from two to five years to make effective the development of large power supplies, it is obvious that with a return to normal business conditions — which all the nations of the world are hoping for — Ontario in five years would be confronted with a power shortage. It will, therefore, be necessary to watch closely the growth in load and other factors in order during the next few years to start still further preparations designed to cope with demands which, it is believed, will inevitably arise in the period following the four to five years already provided for.

The Benefits of Association

Practically every profession or calling has its association or society. It is the organized expression of the art or vocation which it represents, the correlation of the efforts of its members for greater effectiveness.

One of the first returns to an adherent is the appearance of his name in the roster as an accepted and recognized member of the craft. It gives him identification and standing. The membership list of a reputable society is a directory of the leaders in its subject. One of the first moves in evaluating a man is to see if he is a member of the leading society in his profession.

And then there is the opportunity for broadening one's acquaintanceship, the making of friends whose work and interest are in line with his own.

And a wide circle of friends and acquaintances is one of the best assets that a man can have.

One of the advantages for which one most naturally looks is ideas and information that will be of value to him in his work. This he gets in the papers and lectures presented at the meetings and in their discussion. Often opportunities are open for obtaining solutions to his own immediate problems or suggestions for improvement in plant or practice.

And participation in discussion not only broadens his ideas and widens his mental horizon, but also accustoms him to thinking on his feet, gives him confidence in speaking and the ability to get his thoughts over convincingly and to make his point interestingly.

But the most of these advantages come from active participation in the meetings and work of the society. Simply to join and pay one's dues brings some of them. Passive attendance at the meetings brings more. But the one who gets the most out of his membership is he who takes an active, intelligent interest in the proceedings, who wants to know and wants to help, whose willingness and ability to assist lead to his enlistment in committee work, a more intimate and dominant association with his fellow workers, and reputation and advancement in his calling.

As has been often said, the more one puts into his society the more, and in multiplied measure, he gets out of it.—F. R. Low in *Power*.

WOOD POLES

With Special Reference to Western Red Cedar and its Qualities for use by the Electric Utilities.

By M. J. Bell, President, Bell Lumber & Pole Company Minneapolis, Minn.

(Read before Association of Municipal Electrical Utilities at Toronto, January 8th, 1931).

MR. Chairman and Gentlemen of this Convention: The general subject of wood poles being so big that I could not come anywhere near covering it properly during the time allotted to me for talking to you, I have concluded that it will be better for me just to discuss other wood poles a little, in a general way, and confine my talk largely to Western Red Cedar and go into that quite thoroughly which, I believe, will be more interesting to you than if I touched lightly upon subjects pertaining to the different kinds of wood poles without time to cover any of them in the right way.

I have selected Western Red Cedar to discuss quite thoroughly because I believe it makes the best wood poles now in use, when proper treatment is given to the butts of the poles, and because an almost unlimited supply of the best on the American Continent can be secured in British Columbia.

These poles can also be delivered to your properties at what I believe to be a lower cost than any other poles when live cut, properly butt-treated, up to grade poles are used and when every factor of cost is properly figured against the full service of such poles.

The timber most commonly used for poles for some years past has been Northern White Cedar, sometimes called native or eastern cedar; chestnut, Western Red Cedar and southern pine. The pine requires a pressure treatment of creosote or other wood preservative, the full length of the pole, as the wood is similar to our northern norway pine except that it is coarser grained — having wider growth-rings because of its faster growth in a warmer climate—and would decay quickly untreated.

The cedar and chestnut gives very good service untreated, but much better service with the butts properly treated to a point at least one foot above the ground line—as decay will almost invariably start at the ground line first. The reason for this is, that the moisture from the earth is continually working into the sap-wood of an untreated pole at the ground line and then drying out; this change from wet to dry—together with vegetation and disturbance of the earth around the pole—causes the fungi to start and decay to begin quicker at this point.

Northern cedar and chestnut were the first woods commonly used for poles in the eastern and middle-western territory; then, about 28 to

30 years ago, small lots of Western Red Cedar were shipped in for experimental purposes. One of the first car-loads to be shipped to the Lake Superior district came to Ashland, Wisconsin, in the summer of 1902.

These were 8 in. top, 40 ft. poles and are still in use, giving good service. These poles were untreated as no pole-treating plants were established at that time. I have with me a kodak picture of these poles that I took this last year, showing the poles in the line, with wires on, apparently giving good service as ever. I will be glad to show these pictures to anybody who may be interested. Please remember that these 8 in. top, 40 ft. poles have been in service for 28 years and it is estimated that they will give good service for a number of years yet.

The Fowler-Jacobs Company, of Chicago, which has since gone out of business, had a northern pole yard at Washburn, Wisconsin, 12 miles from Ashland, in 1902 and John Fowler, whom I knew well, had an interest in some western cedar pole timber; he shipped the car of poles to Ashland for an experiment and sold them cheap. I, personally, knew about it at the time, and have watched the poles since. These poles were live cut, up to grade, and came from the high altitude territory.

As the Utility and Telephone demand for poles increased, the demand for butt-treated poles began, especially for poles to be set in sandy and gravelly soil further south, where the hot season, and time for fungi to form and start working, is longer. Untreated poles will decay quicker in sandy or gravelly soil, or where the earth has been disturbed by making a fill, than in undisturbed heavy soil.

The first butt-treatment used, and which is still in use as the cheaper one, under the heading of "AA" treatment, calls for not less than a fifteen minute dip in hot creosote. All creosote used for butt-treating of cedar poles must be up to a certain analysis specification. Printed copies of this creosote specification can easily be obtained.

Then a little later there was a demand for a deeper penetration and the so-called "B" treatment was originated, calling for four hours in hot creosote and two hours in cold; the hot oil heats the pole, causing a certain amount of vacuum, and the cold oil acts as a filler and assists the penetration.

Still later the guaranteed "3/8" and "½" inch penetration at the ground line developed, making the incising of the poles at the ground line necessary to cover this guaranteed penetration treatment. It has been fully demonstrated from years of experience by many of the large Utilities that it pays well to butt-treat cedar poles. The "AA" treatment, as well as brush treatment of the poles at the ground line, will retard decay; but although this method is considerably cheaper, it has been fully demonstrated that the "B" or guaranteed penetration treatment, gives a lot more value when figured against the cost.

The lighter treatment, with less penetration, allows the fungi to get started much quicker and frequently the decay will work clear around the pole under this thin treatment, without being noticeable from the outside. Butt treatment is like pole grades—the best is the cheapest in the end.

Untreated Western Red Cedar Poles at right in service 28 years. Picture taken in September, 1930, at 14th Ave., West, Ashland, Wis.

It is unnecessary to treat cedar the full length as the untreated part of the pole will last and give service as long as the treated part will last at the ground line.

Full length treatment of wood poles, other than cedar, had been experimented with, and used to some extent in some of the foreign countries, for a number of years; but it did not get started to any extent, in a commercial way, in Canada and the United States until the past few years. It is now carried on to quite an extent in the United States—the poles being mostly of southern yellow pine. These poles are being shipped to various parts of the country where the freight on their extra heavy weight will permit them to be delivered at a profit. Some of the railways, as well as other concerns in Canada, are also using a few of these full length treated poles.

The most essential thing on a full length treated wood pole is to be *dead sure* of the treatment in every part of the pole; otherwise, the pole will start to decay quickly. Considerable trouble has developed at various times and places in the past because of apparent carelessness, or wrong method in the treatment of some of these poles.

Chestnut is now a small factor in the pole business, as there are only small tracts of live chestnut pole timber left, and most of it that is being shipped to the market is of poor grade and usually, poorly manufactured.

The unsightliness of some of the chestnut poles used during late years has given the Utilities considerable trouble.

There are still places where considerable quantities of northern white cedar can be produced, especially in short poles and small sizes, that are used by many of the telephone companies. Northern cedar timber contains more defects from rot than Western, and many more crooks. A large percentage of the crooks is caused by long periods of heavy winds during the growth of the tree—rot from disease frequently brought about by lack of sufficient moisture to keep the tree healthy. Because of more defects in the northern cedar timber, the pole grading rules for Northern are made more liberal than on Western Cedar.

During the past twenty-five or thirty years, in various parts of the country where northern cedar grows, producers have gone over the ground two or three times, making what is known as second, or third, cutting. As the best of the timber that was still left quite naturally would be taken first, what is being produced now, in many localities, is nearly all under grade.

Two years ago, with a view of looking over northern cedar timber and poles, I made a trip through parts of Ontario, Quebec, and the State of Maine, where there was supposed to be some northern cedar pole timber still standing and being cut into poles. Most of the timber I saw, large enough for Electric Utility poles, was old growth, very defective from rotten knots and rotten butts, and the poles already cut at railways, contained more defects and a larger per cent. of undergrade stock, than I had ever seen in northern poles.

For some years past the Electric Utilities have been unable to get the necessary long transmission line poles from northern cedar, because of its shorter growth and not enough of its popular lengths from 30 ft. to 40 ft., so they turned to Western Cedar and have been using very large quantities of Western Red Cedar poles. Besides its other qualities, the Western Cedar pole is very straight and makes a beautiful line.

By painting and staining these smooth and straight western poles before they are set, many of the Utilities have eliminated complaints from cities and villages about unsightly poles being erected, thereby saving themselves a lot of trouble, as well as a lot of money. Full length creosote poles cannot be painted—as the creosote will eat up the paint.

Care should be taken as to the kind of paint or stain used, as the regular linseed oil paint will close the pores of the wood too much and frequently cause early sap-rot to start in the untreated portion of the pole. A proper mixture of a base creosote oil, with the coal tar coloring out, with the best grade of ground in oil paste to give the proper color, is the safest mixture I know of for staining poles; as the creosote oil acts as a preservative and, with the small amount of linseed oil in the paste, it does not close the pores of the wood like regular paint. I have experimented with this mixture and find that it will hold the color well, is cheaper than regular paint, and much better for the pole. It can

be put on with a sprayer or with a regular brush.

The specie of Western Red Cedar best adapted for poles is found through various areas of the timbered sections of British Columbia, the States of Washington, Idaho and Montana. It is one of the family of evergreen trees—evergreens do not shed their leaves in the winter. It requires considerable moisture from the ground to keep it in a healthy growing condition, consequently large quantities of the best cedar pole timber will be found growing among other timber, where it is thick enough to shade the ground well and retain sufficient moisture for the cedar.

Cedar is seldom found—and will not thrive—on the sandy light soil where large quantities of the so-called western yellow pine, norway, and jack-pine, grows—as its roots do not penetrate deep into the ground to seek moisture in the way yellow and jack-pine does.

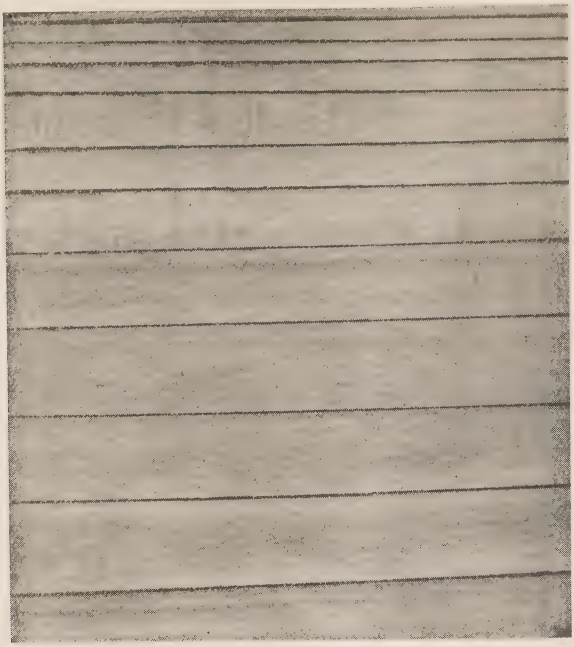
The good Western Cedar is largely found growing with the fir, spruce, white pine and larch (tamarack) from the lower sea level valleys along up to the higher plateaus. In various places covering small areas, especially if the ground is continually moist from being fed by springs, the cedar predominates and crowds out most other species of timber—this would usually be termed a cedar swamp. Cedar growing on springy ground is always very sound—proving that plenty of moisture keeps the tree healthy. The moisture in the ground which causes good cedar to grow on the plateaus at high altitudes, comes largely from the seepings of water into the ground from the snow higher up.

Cedar grows faster in the low altitudes because of the longer and warmer season; the growing season is shorter and it is colder higher up. Even in the high altitudes the tree will grow faster on the southern slopes where it is exposed to the sun all day, than on the more shaded northern slopes. This difference can easily be detected in the width of the growing rings of the wood. There is a very pronounced difference in the width of the growing rings on a tree grown at, or near, sea level, and one grown 2,000 to 3,000 feet above. The low altitude tree grows much faster, consequently the wood is softer and the growing rings much farther apart.

To better illustrate, here is a sample of wood taken from a cedar tree growing at approximately sea level, and one from a tree growing at about 2,500 feet altitude.

During the growing season, the saliva between the bark and the wood of a healthy tree is continually forming into a new cycle of wood and makes a new cycle, or ring, of wood each year. Favorable growing weather has the same effect on the growth of trees as on the growing of anything else. The growth-rings will be larger after a long, warm season, with plenty of moisture, than after a short, cool, or dry season.

The slower growing Western Red Cedar from the higher altitudes, in texture and density of the wood, is much nearer in its wood-fibre to the native eastern cedar caused, of course, by the shorter growing season; the grain of the wood being finer, naturally makes the wood harder than the faster growing variety.



Sap Wood

Cedar grown at sea level.

Sap Wood

Cedar grown 2,500 ft. above sea level.

The untreated part of any pole taken from this slow growing, finer-grained, high altitude cedar, will last longer while exposed to the weather than the faster growing kind. For confirmation of this, everyone who has had experience knows that our slow-growing northern oak will last much longer in railway ties, or timbers that are exposed to the weather, than the faster growing southern oak. Canadian and United States government tests for breaking strength have also shown the slower growing cedar to be considerably stronger. So there is a difference in the strength and lasting quality of Western Cedar poles—depending on where they are produced.

The Western Red Cedar tree and cedar pole has less taper than the eastern or northern white cedar, but the Western Cedar grows much straighter and smoother, which is easy to comprehend if a little thought is given to it. On account of less severe winds in the western timber area, with usually better distribution of moisture, nature makes the trees grow taller.

When the growth of the forest is well under way, certain varieties grow faster than others and cedar being naturally a slower growing tree, and usually shorter in length than some others, which may largely predominate, causes the Western Cedar to stretch up to get the sun. The taller the other timber in the forests where cedar grows, the less taper usually found in the cedar. Breaking tests have shown the Western Cedar to be stronger than the eastern or northern white cedar which, to a larger extent, overcomes the difference in taper.

Another point in favor of the cedar grown on the higher altitudes is that the predominating trees and average timber are not tall; consequently the cedar grows stockier and has more taper. When the cedar tree grows tall enough so that sun can reach the top of it through the other timber, the body of the tree will then grow stockier.

Because of the shorter lengths of the high altitude cedar trees, nearly all of the poles are butt cuts and as a maximum amount of the natural wood-preserving chemicals of the tree settle to the butt, these butt-cut poles are better than poles taken from taller trees where logs have to be cut from the butts of the trees in order to get the poles to the right size and lengths.

To produce the best results, no cutting and peeling of cedar poles should be done during the hot, mid-summer months, when the maximum amount of sap is up and forming the new wood cycles, unless the poles are being skidded into the water within 24 to 48 hours from the time they are cut. Otherwise, the ones in direct contact with the hot sun will frequently show a large deep check in one place, caused by seasoning faster where the sun hits. Others, where shaded by other timber, may show some mildew when there is no wind and the warm air contains too much moisture.

Standing cedar timber, like other varieties, will die of old age and of disease—and is also killed in large quantities each year by forest fires. A dead cedar tree, if not dead long

enough to be too much impregnated with fungi, when cut into a pole will give considerable service; as the natural chemicals in the heart-wood will resist decay for some time after the sap-wood is practically useless as far as strength is concerned. Live, sound, sap-wood will stand more bending before it breaks than the heart-wood.

Barring the real old growth cedar, too large for poles, which frequently starts to die of old age at the top, while it is also rotting at the butt near the ground, the first process of decay when a tree starts to die is the drying up of the saliva between the wood and bark—which is really the life-blood of the tree. When the saliva dries, the bark will usually stick tight to the tree until insects, attracted by the odor from the dead saliva, start working in it and loosen the bark.

After the saliva dries up, the sap-wood continues to dry and get brittle, and the decay continues to work into the tree. Under a powerful magnifying glass, the decay will show up in fungi form—sometimes resembling small vines, frequently close together, in a piece of dead wood that looks perfectly sound and good to the naked eye.

Under present conditions, it certainly does not pay to use wood poles of any kind made from dead timber, because one-third to a half of the length of life of a live-cut pole may be gone from the dead pole before it is set in the line. Many undergrade poles are being sold in the market by unreliable shippers to users who are not well posted on grades, and to some other users who buy them at lower prices than good up-to-grade poles can be sold for, and who believe they are getting a bargain. It is very expensive to replace poles in a line without materially interrupting service; so the live-cut up-to-grade pole is always the cheapest in the end.

It has been thoroughly demonstrated and proven by experts, experimenting with wood, that a pole, or piece of wood, already impregnated with fungi, placed in a pile of good healthy poles, will carry the disease and impregnate the healthy poles.

The sap-wood on a green cut pole, while it continues in a healthy condition, acts as a strength-band around the heart-wood of the pole; so the dead tree pole, because of the sap-wood dying first and becoming brittle has considerably less strength than the green cut one—even though it has been dead only a short time.

A dead tree, or dead pole, that has been attacked by fungi, is also very susceptible to attack by insects; ants will frequently work up into weakened parts of the wood-fibre and build their nests—sometimes making a honeycomb of the wood from the inside—leaving only a small shell of wood on the outside. The location of an ant's nest in a tree or pole can be quite easily detected by careful examination, as it will invariably have an opening from half the size to the full size of a lead pencil opposite to, and leading into the nest from the outside of the tree or pole, as the case may be. Ants will not attack sound, live, timber.

An easy way for an amateur to tell a dead pole from a green-cut one is to take a very thin shaving from the outside of the pole and try to bend it;

if alive it will bend—if dead it will break quickly.

For safety, only green-cut poles should be used and when they are stored in a yard for any length of time, including the spring, fall and summer months, especially the summer months, they should be either on sound creosoted wood-skids, or on concrete, or iron skids from 1½ feet to 2 feet above the ground, to permit good circulation of air. No rotten wood or old rotten poles should be stored in the same yard. It is also much safer to remove all weeds and vegetation that may come in contact with the poles, as fungi may start in the yard—although not visible to the eye—and develop on the poles after they are set in the line. Unclean yards of producers and shippers of poles, as well as the storage and handling yards of the Utilities, have caused lots of poles to become infected and to start decaying, sometimes years before they would start to decay, if properly handled.

In addition to great durability and strength, cedar is one of the lightest of woods. Its specific gravity in a seasoned condition is about .29, less by several hundredths than other timber most commonly used for poles—and considerably under the average of all timber used as poles.

The light weight of cedar makes it much cheaper to handle and haul to the places where it is required in the line, as nearly double the number of pieces can be hauled at a load and it requires fewer men to handle and erect the lighter poles.

Any pole with much moisture in it has a great attraction for lightning. While it is obviously impossible to find a pole that is positively immune, it is clearly seen that cedar does not have a natural affinity for it, and that the number of these particular poles that will be struck by lightning is far less than poles that have better moisture absorbing qualities.

Broken insulators are not uncommon in transmission lines anywhere. In such cases the non-conductor properties of cedar are highly valuable, as usually current deflation and line losses will be very small until repairs can be made.

Line men are safe on cedar poles. Without moisture in the poles the workmen are seldom grounded on the pole and subjected to sudden electrocution.

Cedar is also more highly resistant to decay than any other wood commonly used for poles. Butt rot of cedar does not go on in the pole after it is cut and thoroughly seasoned. When butt rot *is* present, it is a disease of the live tree and not of the seasoned pole.

The minimum percentage of butt rot under the cedar specification does not increase after the pole is set. Most Western Red Cedar poles are perfectly sound at the butt, as the trees are generally sound at the stump when out.

All the poles handled and shipped by legitimate dealers are sold on certain specifications. Unless something special is requested by the purchaser, the regular standard specifications are used. W.R.C.A. specifications on Western, and N.W.C.A. on northern poles, mean top circumference measurement only, with the pole up to grading rules in other respects.

N.E.L.A. or A.T.T., usually referred to as Class specifications, calls for certain circumference measurements at the top and at a point usually six feet up from the butt. Printed copies of all these specifications can easily be obtained.

Many of the Utilities are using large Class grade Western Red Cedar poles, butt treated either single or of "H" line construction instead of steel, for long transmission lines. A paper read not long ago at an N.E.L.A. convention by one of their well-known engineers, who had made a study of the economy of wood poles against steel for transmission lines, has switched a lot of them to wood.

As I am nearing the end of my talk, please keep in mind that, when finished, I will be glad to answer any questions that may be asked from the floor; or will further discuss any of the things I have talked about with anybody who may be interested, after the convention has adjourned.

In conclusion I want to say that it is usually considered that the average timber-man is inclined to be a little hard-boiled—but my experience has been to the contrary—even though it sometimes may appear so on the surface. A man who tramps through the forests a lot and sees the great works of nature, just can't get that way.

My experience among the trees in the great out-doors has always been very fascinating, and I seldom look at a large tree that towers above the others, without thinking of my favorite poem entitled "*TREES*", by Joyce Kilmer. If you will bear with me a moment longer I will close by reading it.

TREES

I think that I shall never see
A poem lovely as a tree,
A tree whose hungry mouth is prest
Against the earth's sweet flowing
breast;
A tree that looks to God all day
And lifts her leafy arms to pray;
A tree that may in summer wear
A nest of robins in her hair;
Upon whose bosom snow has lain;
Who intimately lives with rain.
Poems are made by fools like me,
But only God can make a tree.

Discussion

Mr. Jos. Gibbons, Toronto: I should like to ask Mr. Bell if, when he gets a contract for Western Cedar poles in Canada, they come direct from British Columbia or from Minneapolis.

Mr. Bell: It would depend on how much of a rush you were in. If you wired us to rush them we could make a little quicker time out of Minneapolis. If you said to send them from British Columbia, we would send them from there.

Mr. Gibbons: If they are shipped from Minneapolis do you not have to pay duty on them going into the the United States.

Mr. Bell: No, there is no duty whatever. They are in what we call "storage in transit". If we put them into the yard we have eighteen months to take them out.

Mr. A. G. Lang, H.E.P.C. of Ont: During the last twelve months the Commission has built 1,891 miles of new rural lines, and that has taken a lot of poles. I think that 57,773 poles were bought by the Commission for current use during the past year.

The poles that we bought were not western poles, but eastern cedar poles. One reason that we bought them was because they were cheap — and they were good. They are not scarce, but they are not sightly — they are not as sightly as the western poles. I do not think that during the year we have had a single complaint about their unsightliness. I do not know why the people do not complain, but they don't.

As far as the cost of our poles is concerned, we got a good price, and it has been going down, not up, for the past few years. We have had prices from Mr. Bell's company and have looked them over very carefully. We have figured up the life and the annual charges and we find that our native eastern Cedar is economical. Last year we bought 57,000 poles and will buy 57,000 this year, and we have no difficulty in getting them, and they meet our specification.

Mr. Bell: Mr. Lang said there were lots of northern poles. I believe that is true in certain localities. He may be fortunate enough to be able to get plenty of them for some time to come. If he treats the butts they may last; but if the utilities had not gone to Western Cedar poles ten or twelve years ago, there would not be any Northern Cedar to-day.

Mr. W. R. Catton, Brantford: We built in our town with Western Cedar, and we are scared to replace one of our poles with a crooked Eastern Cedar. I don't think our folks would allow it. Our first experience with Western Cedar was not so good, but since then we have learned that the low altitude pole is not as good as the one grown in the high altitude, and now we are getting a good straight pole.

Mr. S. Elliker, Forest: What is the average life of the Western Cedar pole, butt treated, and used in very sandy oil ?

Mr. Bell: It will depend very largely on whether it is placed in this northern latitude or down in Oklahoma, for instance. It won't last as long down there. It all depends on your latitude. I could refer you to various lines that have been in existence for a number of years in a sandy soil with the result that the sap is practically all gone; I could also refer you to treated poles which have been set for eight or ten years and which have not deteriorated at all. The incising treatment is more or less of an experiment; it has not been in existence long enough to tell you definitely much about it.

We try to make the ground line last as long as the top of the pole. I could give you instances of poles in the Lake Superior district, and in this climate, that had been standing for twenty-eight years, and it is expected that they have at least twelve years of life in them yet. That means a life of forty years. They are in clay. Where there is a fill or where the ground has once been disturbed, they will not last as long. It is hard to determine the average life of a pole.

Mr. Elliker: In our municipality

we have had Western Cedar poles, untreated, for about fifteen years.

Mr. Bell: Are you quite sure that when you got the poles you got strictly live cut poles? That is important.

When they started to figure up the local chestnut pole as cheap in comparison with the first class pole there was a big rise in price. There are a bunch of fellows in the trade known as postage stamp men, who buy with postage stamps and sell the same way. There are fellows in the pole business who have gone out to our producing areas in the west and tried to buy two or three carloads of cull poles. They shipped some of them to Ohio. They were straight and looked good. Some of those fellows are cutting poles that have been dead for two or three years, and shaving them up and selling them. But the fellow who knows the game can give you good stuff.

Mr. V. B. Coleman, Port Hope: What is the length of the pole you are using ?

Mr. Elliker: 40 feet, with an 8-inch top.

Mr. Bell: You will find some in sandy soil that will stand for a great many years. In some soils there is a mineral that will destroy the pole.

Mr. A. E. Davison, H.E.P.C. of Ont: One utility company at least on the Atlantic seaboard is developing a process for boiling the whole pole. I wonder whether we are altogether right in treating only the butts of these cedar poles. It is good for pine; is it not good also for cedar? Also I would like to know something also about the cheap pole that Mr. Bell talks about. What is an 8-inch, 40-foot pole worth when it is cheap ?

Mr. Bell: With reference to the treating of the full length of the cedar pole, it is different from the pine. The pine pole would be practically useless untreated. It is treated under pressure; we do not use pressure on cedar. The natural chemicals in the heart-wood preserve it for many years. The pine is all sap-wood, practically, and the heart-wood is small. It is absolutely no good unless treated. Southern pine will start fungi growth in 60 days. The whole idea is to treat the ground line of cedar so that it will last as long as the exposed top. If you give pressure treatment to the full length of the pole the poison in the creosote will leave the ground line first while the top is still giving first-class service, and the tendency is not to shove poles down but up, so full length treatment has proven unnecessary.

The pole that I referred to as being cheap, was shipped in by that fellow twenty-eight years ago. From our point of view we are still selling cheap poles.

Mr. R. H. Starr, Orillia: I would like to compliment Mr. Bell on his paper. I have certainly enjoyed it. I think the Western pole is the pole. We have had Western poles on the streets for eighteen years, and they look to be good for another five years anyway.

I would like to ask one question. I notice that on some pole lines they are digging out around the ground line and scraping off the sap-wood and applying creosote. Have you any knowledge of that?

Mr. Bell: I have investigated some

of that work and I really believe that it does not pay. It is almost impossible to get any penetration into the heart-wood of cedar. The natural chemical is there. I think they are wasting time and money in digging down and trying to get penetration into the heart-wood.

Mr. Wills MacLachlan, H.E.P.C. of Ont.: Mr. Bell refers to the checking of the sap-wood in dead poles. We have had a number of accidents through the linemen's spurs cutting out in Western cedar with a long sliver of wood that looked like sap-wood. Is it reasonable to suppose that those were dead poles when purchased, or might that occur also with live cut poles ?

Mr. Bell: It would be a great many years before a live cut pole would show anything of that kind.

Mr. MacLachlan: This was eight or ten years after setting.

Mr. Bell: If you cut the pole green the sap in the sap-wood will last, if it is well-seasoned, for a number of years, and will preserve the sap-wood from becoming brittle. If you have a pole that has died the sap-wood will start to become brittle immediately. Also, on the side next to the sun it will open up very quickly. Some years ago a lot of dead poles were shipped into this territory and into the states. Some people bought them with the idea that they were getting a bargain; but it has been demonstrated by the experiments of the forestry department that those poles might be impregnated with fungi clear to the heart.

Mr. MacLachlan: One thing that sticks out like a sore thumb is the fact that we do not have this experience with Eastern cedar but that we do have it with the Western cedar. We have been wondering why.

Mr. Bell: Your local cedar is much cheaper, and the fellow was trying to get you a pole on which he could talk price, and the only thing he could ship from the West was an under-grade pole. He did that with a view to selling you good poles later on. That has been done, but not by reliable firms.

Mr. T. F. Howlett, H.E.P.C. of Ont.: What about a pole of which part is still alive and part dead? Will that last as long as a live pole?

Mr. Bell: It is not supposed to. Sometimes a pole will be killed by a windfall striking the side of it, and occasionally a pole may start to die on one side. The specifications require an over-size pole; in other words we have to have a larger circumference. It has to be over-size if it is 25 per cent. dead. Under the W.R.C.A. specifications occasionally there is a little stripping allowed. If it is more than 25 per cent. it is a dead pole.

Rewiring More Costly Than Providing for Future

A FEW EXAMPLES MAY SERVE TO ILLUSTRATE HOW HIGH REWIRING COSTS MAY RUN AND HOW THOSE COSTS ARE LESSENED BY MAKING THE ORIGINAL INSTALLATION ADEQUATE OR BY PROVIDING EASY REWIRING FACILITIES WITH THE ORIGINAL WIRING.

A firm of stock brokers desired to install lighting which meant raising the wiring capacity from 2 watts to 7 watts per square foot. As the building where the change was to be made had not yet been completed, the additional wiring could be added for $7,000. The consulting engineer estimates that the same change made after the building was completed and in use would have cost $20,000.

* * * *

A department store, fifteen years old, has already found it necessary to rewire large sections three times, each time failing to rewire for the future. Now, the entire main floor and show windows are about to be rewired again at a further high cost, to obtain the modern lighting that it is felt is desirable.

* * * *

A two-story garage, about 30 x 125 ft. was rewired in 1926. Desire for more light made it necessary to install a new service and increase the number and size of circuits within three years. This cost 300 per cent. more than if the work had been done at the time of the first rewiring.

* * * *

In the plans for a small department store, wiring was laid out for 1½ watts per square foot and 100 watts per 18 in. of show window. After this wiring had been roughed in the owner became convinced that it was inadequate. Additional capacity was installed, giving 3½ watts per square foot and 200 watts per 18 in. of show window. This additional work raised the cost of the wiring installation 30 per cent. and this was $2,500 in excess of what it would have been had the wiring used been called for in the original plans. If it had been necessary to rewire after the building had been completed, to obtain this increased capacity it is estimated that this $2,500 excess cost would have been $12,000 or even more.

* * * *

It must be remembered, too, that there are many buildings where the design makes it impossible to rewire at any cost, without destroying the artistic beauties of the building, no matter how great the need for increased service may be. This condition exists solely because in the wiring, now an integral part of the building, a few mills a foot was saved by installing copper that was not capable of taking care of increased requirements.—*Electrical World.*

Time Payment Sales

By John C. Emo, Industrial Acceptance Corporation Limited, Toronto

(*Presented to Association of Municipal Electrical Utilities at Toronto January 8, 1931*)

THIS paper has been prepared with the object of outlining the soundness of instalment selling when properly applied and to provide some helpful thoughts to merchants selling on deferred payments so that they may avoid the pitfalls which surround any form of merchandising when improperly administrated.

Much has been said and written in recent years regarding instalment selling, and one would almost be led to believe that the system is some form of new invention. As a matter of fact the plan has been used for many years by furniture houses, sewing machine manufacturers, printing houses and other similar firms. In fact history tells us that a contemporary of Julius Caesar amassed a fortune by building houses in the outskirts of Rome and selling them on the instalment plan.

The reason why instalment selling has attracted so much attention in recent years is due entirely to the increase in the use of the system. This increase has been a natural development of our modern credit structure, and this can be readily understood by briefly analyzing the kinds of credit which make up this credit structure. Classifying credit according to the use to which funds or commodities borrowed are put, we have three main classifications — Investment Credit, Commercial or Production Credit and Consumptive Credit.

Investment credit comprises funds borrowed for use in the creation of fixed or durable goods such as the development of railroads, factories, mines, etc. Funds obtained under this class of credit are usually paid back over a period of years from the return earned on the investment.

Commercial or Production credit is that which is used in financing the production, manufacture and marketing of goods in operating an establishment as a going concern. Funds obtained under this class of credit are usually paid back in a short time through the turnover of the commodities manufactured.

Consumptive credit refers to the granting of loans or the selling of goods on time to individuals who use the money or goods received for the satisfaction of consumptive wants. The repayment of these obligations is usually not made through income derived from the use of the goods but from income from other sources.

The development in recent years of Investment and Production credit has been tremendous. Is it therefore not logical that there should also have been a correspondingly great increase in consumptive credit or instalment buying ?

An example may further illustrate this—The X Radio Corporation is organized to manufacture a certain type of radio. Through the use of investment and production credit, radios are manufactured and placed on the market. In order for this radio to reach the home of the consumer, further credit is required. John Jones, the purchaser, takes his share of consumptive credit and buys the radio on time. Therefore, it is evident that an increase in both investment and production credit makes a corresponding increase in consumptive credit.

Is Instalment Selling Sound?

In the example just stated above if the X Radio Corporation is entitled to credit to manufacture radios, is there any reason why John Jones should not be entitled to credit to purchase one ?

A short time ago interests who had millions invested in consumptive credit paper, analyzed the effect of instalment selling from all phases and under all sorts of conditions. They, of all people, were vitally interested in the soundness of instalment selling. This analysis was made by a staff of economists, in charge of Professor E. A. R. Seligman of Columbia University, who worked on the subject for over a year.

The results of this investigation proved beyond doubt that, provided instalment selling is surrounded with reasonable safeguards, and that the system is not abused, the consumptive credit involved is as sound as the other forms of credit in our credit structure.

The following are a few points which cannot be overlooked when considering the soundness of instalment buying and selling—

During the period of intense growth of instalment selling in the United States—some thirteen years up to 1927 — savings deposits increased 175 per cent., life insurance 445 per cent., while there was a corresponding growth in assets, members and numbers of building and loan associations. There was also an astounding rise in the per capita wealth of the nation, an increase from $2,819 in 1920 to $4,406 in 1927.

It would seem that such facts prove that instalment selling encourages thrift and disproves the claim sometimes heard that it causes people to spend their savings to meet instalment obligations.

It has been objected that instalment selling encourages the purchase of luxuries by those who cannot afford them. Who can call any article a luxury? In early days the chariots of emperors were great luxuries, to-day the average working man would not like to be seen riding in one. Some years ago leather boots and shoes were considered a luxury, to-day they are one of the bare necessities of life. The so-called luxuries of yesterday are the necessities of to-day and instalment buying has helped to raise the standard of living and provided a live demand for modern comforts, conveniences and enjoyment of the masses.

The past year has been a real test for instalment selling, yet reports from the large finance companies in the United States indicate that there has been only a very slight increase in delinquent accounts. Most Canadian companies, perhaps through

closer following of collections than in previous years, found that the past due percentage of paper over thirty days delinquent at the end of 1930 was actually less than at the end of 1929.

INSTALMENT SELLING AS A MEANS TO INCREASE PROFITS AND NOT VOLUME ONLY

It has been said that instalment selling is sound providing it is surrounded by reasonable safeguards. These safeguards are what the merchant should know and consistently apply to his instalment sales.

1. Reasonable credit judgment as to purchasers
2. Sensible down payments, terms and charges.
3. Efficient collection organization.

1. *Reasonable Credit Judgment as to Purchaser:—*

Credit has been called the main spring of business. It is also the main spring of successful merchandising on the instalment plan. Many merchants have sold on time payments without regard to the ability and intention of purchasers to meet the required payments and when the repossessions came along, which were inevitable in view of the manner in which the sales had been made, they condemned the instalment plan. Such condemnation is obviously unfair.

A reasonable investigation of the purchaser's credit standing in his community should always be made before the closing of a sale on deferred payments.

Salesmen are too frequently hesitant in asking questions which will enable the merchant to judge the risk involved. They fear that their purchaser may be insulted or embarrassed and the sale may be lost. The fact is, however, that the average good credit risk is proud of his credit standing and is glad to give information regarding it. It is usually the poor risk who becomes highly indignant at any reference to his personal affairs. Sales to the latter type are better if lost.

Experience has proved that the following factors are extremely important as an aid to judging the class of risk involved in a deferred payment sale.

Present Residence Address and Length of Residence.

Credit can often be judged by the class of district where the purchaser resides. The length of residence is a guage of stability. Purchasers with hotel addresses and post office box addresses in larger centres are extremely dangerous in view of the possibility of such purchasers leaving for parts unknown.

Present Occupation and Length of Employment.

The occupation of the purchaser is of paramount importance, for no matter how good his intentions to pay may be, if his income ceases it is impossible for him to do so. The length of employment, also, indicates the stability of the purchaser and whether his employment is permanent or of a temporary nature. A merchant knowing his community, can usually judge the permanency and scale of wages or salaries paid by various business houses, factories and stores. Employees of railways, Government employees, school teachers, firemen, policemen and other civic

employees are usually good credit risks. Certain types of travelling salesmen, agents of various kinds, employees working on commission, employees engaged in seasonable work, mining stock and similar salesmen, taxi-cab drivers, etc., are usually, though of course not always, found to be poor risks for instalment obligations.

References.

The best reference that can be obtained is of course one with whom the purchaser has had credit dealings. Personal references are of value as to the class of reference given and are also of great value should the purchaser change his address. Where the purchaser does not own his home the landlord is a valuable reference, as the regularity in which rent is paid is a good indication of a purchasers promptness.

Has the Purchaser bought on the Instalment Plan before and has he another Obligation at the Present time.

The former payment record is a valuable guide to the purchasers credit. It is also most important to know if he already has an obligation to take care of. He may be a good risk for the obligation already incurred, but the additional obligation may make him a poor risk through assuming more than he can meet promptly.

It is important to know the age of the purchaser only to be sure that he or she is not a minor.

The simplest method to obtain the information mentioned is to have the purchaser fill in a small form which can be part of the Conditional Sale Contract. A salesman using discretion can often obtain valuable information without the purchaser knowing it. For example: if he wishes to know the name of the Bank where the purchaser maintains his account, he can say, "Oh yes, you bank with Mr. Jones at the Royal." In nearly every case the purchaser will correct him if he is wrong and tell him the bank he deals with, without realizing that he is giving credit information in regard to himself.

Having obtained the information deemed necessary above, it is an easy matter to check references, etc., by phone or through credit agencies for a nominal charge, in the larger cities.

A valuable credit check which is used by a number of radio firms selling largely on deferred payments is to have an employee of the store call on the purchaser a week or so after the set has been installed. Under the pretense of a service call which is usually appreciated, the employee enters the home and turns in a report on the neighbourhood, class of home, furniture and surroundings. This call at the same time builds goodwill for the merchant.

2. *Down Payments, Terms and Charges.*

Although losses incurred through instalment sales have been exceptionally low, in comparison with open account credit, experience has proved that losses vary in direct proportion to the amount of down payment collected and length of terms extended

The amount of down payment and terms of payment which can be considered as reasonable and sensible,

vary according to the kind of commodity sold. The important factors which should govern the merchant in deciding on his policy is the depreciation of the collateral and the equity established by the purchaser.

Down payments of 20 per cent. to 25 per cent. and terms of twelve months can be considered as sound and conservative terms on electrical appliances although such commodities as electrical refrigerators, generally sold to home owners, have been successfully sold on down payments as low as 10 per cent. and terms up to twenty-four months for some time. The generally accepted down payments and terms on automobiles, on the other hand, are one-third down on new cars, 40 per cent. on used cars and twelve months' terms.

The purchaser who buys on the instalment plan receives something more than the cash buyer—this something is accommodation. It is, therefore, only reasonable that he should pay for this additional service.

The additional charge should fairly cover the cost to the merchant of extending the accommodation that is, interest, cost of credit investigations, collections and administration.

A point to bear in mind when explaining the charge to a purchaser is the fact that a leading authority has estimated that if it were not for the mass production and mass consumption that has been made possible by instalment buying and selling the present net price of most articles would be 10 per cent. to 25 per cent. higher than they are to-day. This means that even though it is necessary to pay a little more for the credit extended, the instalment plan has already made possible a substantial saving to him.

3. *Collections.*

An efficient collection organization is essential to the success of instalment merchandising. No matter how careful a merchant may be in his judgment of purchasers, there are always some buyers who require close attention in order that their accounts may be maintained in a healthy condition.

A neglected delinquent account may develop into a repossession through the purchaser feeling that he has become hopelessly behind in his payments. It is always easier to collect one instalment than two, at one time, and a close follow up is required to keep the tardy purchaser paying regularly.

The telephone is an efficient and inexpensive collection medium, and a definite system should be maintained. A number of firms make a practice of calling in the evening between six and seven, and as no one likes to be disturbed while enjoying their evening meal, this practice proves very effective.

Extensions should only be granted when well merited, and the merchant should not hesitate to repossess the collateral when the purchaser shows from his actions that he is not deserving of the credit extended to him.

The handling of collections courteously and efficiently is one of the main reasons why the finance companies have played such an important part in the growth of instalment selling. The finance companies have specialized in this field and with their experience and trained personnel are able to render the merchant an

efficient collection service, at the same time eliminating the cost to him of maintaining his own collection organization.

Increasing Sales Through Instalment Selling.

To thoroughly cover the complete market of a commodity such as an Electrical Refrigerator or a Range, instalment selling must be used. If sales are restricted to cash sales only, the merchant will find, as a general rule, that he is only reaching the small "class" market of families with incomes of approximately four thousand dollars a year and more. The "mass" market of families with incomes of less than four thousand while low in unit purchasing power represents probably the most tremendous buying power in the country.

Although instalment buying is by no means restricted to this latter class, it is the method of buying which they have found most satisfactory to their pocket books. The objection of this class to saving the amount required before the purchase of a much desired article is the fact that this fund is seldom completed, whereas the instalment purchase is a definite obligation which must be met regularly. The article is also enjoyed while the obligation is liquidated which is, of course, an attractive feature of the plan.

To attract this market, then, the merchant should make it known to his prospects that he is quite prepared to sell on terms. The average person does not like to ask for credit, and when only the cash price of an article is displayed, the thought "I can't afford it" comes to the prospects mind and sales resistance is set up immediately. The amount of down payment and amount of monthly payment required should therefore be displayed prominently in preference to the cash price of the article.

Occasionally, prospects will state that they can't afford an article and also state that they "never buy on time." People who make this latter statement usually do so without giving the matter much thought, for is it not a fact that practically everyone buys insurance on time, buys a home on deferred payments, even pays rent and telephone cost in instalments.

Has Instalment Selling Been Used to Develop Sales in the Electrical Appliance Field to the Same Extent as in Other Fields of Merchandising?

In certain lines of the electrical appliance industry time selling has played a most important part in developing wide markets. Such products as washing machines, vacuum cleaners and sundry electrical appliances have been sold in recent years on deferred payments to as large an extent as any other field of merchandising.

A general analysis of radio sales would indicate that some 80 per cent. of sales are made on a basis of time. It would appear, therefore, that the radio industry has developed its market to a point to which, with less aggressive selling, it might not have reached for some time.

Deferred payment sales in the electrical refrigerator field do not appear to have been developed to the same extent as the products just referred to. An analysis of this field would indicate that somewhat less

than 60 per cent. have been sold on a time basis. Although, perhaps one of the reasons for this lower percentage of time sales is due to the fact that home owners represent the majority of purchasers, nevertheless, it would seem that this market offers a potential volume of business through more aggressive merchandising on time basis.

A comparison of the foregoing with the automobile industry which is generally considered as one in which instalment selling has been highly developed, and in which time sales have ranged from sixty to seventy per cent. in recent years, indicates that with the possible exception of the electrical refrigerator field, the electrical appliance industry is developing its time market progressively.

Discussion

Mr. H. T. MacDonald, H.E.P.C. of Ont.: I would like to know the basis on which you work in arriving at the percentage of the down payment on various commodities. They range, you say, from 35 per cent. to 10 per cent.

Mr. Emo: Experience is perhaps the best basis on which to decide the policy to be followed. The question of the down payment in instalment selling is one in regard to which there has been any amount of discussion. We see radios advertised for $5 down with a payment of $2.50 a week. I do not think there is any doubt that the merchant selling on a small down payment such as that has an abnormal number of repossessions.

In deciding on the down payment, for example on an electrical refrigerator, the class of purchasers buying the article and the depreciation involved, and the equity established by the purchaser have an important bearing. For example, on a refrigerator there is a certain saving effected by reason of the purchaser not having to buy ice. The usual type of buyer is interested in his home, and the refrigerator becomes part of it. I imagine the down payment on a refrigerator might be lower than on some other commodities.

Radios, though sold on small down payments, are often subject to great depreciation. Even a down payment of 20 per cent. can be wiped out, and the purchaser may find himself with more to pay than it will cost him to go out and buy another radio.

On the other hand, the credit involved in the sale is important. The down payment rule does not have to be hard and fast. A poor credit risk may have $50 to pay down on a $150 article, and that $50 may be the last payment that he will ever make on it. Another risk, with an assured income, may be able to pay only $10, but due to his ability to meet payments and his credit attitude, will pay every instalment.

The amount of the down payment varies with experience. In certain towns an article may be sold for smaller down payments than in others. For example, in a town in the Province of Quebec, where pulp and paper is the main industry, the merchants have learned that selling on low down payments is unprofitable. When the pulp and paper mills operated on short time, or in

some cases closed down altogether, the earnings of the paper makers were reduced to perhaps one-quarter of what they had been, or even nothing at all, and in a number of repossessions that were made there was more owing than the resale value of the commodity. In another town where industry is not subject to such changes a commodity might be sold on a smaller down payment and that risk would never occur.

Mr. H. F. Shearer, Welland: Mr. Chairman, I understand that some of the larger utilities across the line are making quite a decided success of the group selling of appliances and extending the time of payment. I have in mind one organization that is selling a range, a refrigerator and a water heater, and extending the payments over from 24 to 30 months. Supposing we had a down payment of 20 per cent., would we be justified in taking a smaller down payment on the whole group in view of the fact that the terms are extended beyond the usual 12 months.

Mr. Emo: I would think that in a case like that, the purchaser would probably be a home owner. The total installation is put in the home on the basis of time. In that case where, as I say, refrigerators have been very successfully sold on small down payments, I would think the down payment on the group would be just as safe for you if the credit risk of the purchaser makes it safe. The question of terms up to 30 months is largely a matter for the utilities to decide upon in whatever locality they happen to be working in. They will probably try out that system in a certain section in a small way. If their experience is satisfactory with it then they will enlarge it as a definite part of their sales programme. One of the reasons of the group is the fact that the total obligation is a very large amount. This in turn makes it possible for them to exert more collection effort to protect the equity than in the case of a number of small instalments of $5 or $10.

Making Friends of the Public

By A. G. Evans, Assistant to Chief Inspector, Toronto Hydro-Electric System.

(Read before Association of Municipal Electrical Utilities at Toronto, January 9th, 1931.)

WHEN I was asked to give a paper at this meeting to deal with methods of meeting individuals—our consumers—who, taken collectively, are spoken of as the public, it seemed to me that there is need of a paper that will go a little farther than to list certain methods of meeting the public and answering their enquiries or complaints. A subject dealing only with such matters implies a rather negative mental attitude of waiting until some one comes in, whereas we should all have the positive attitude towards our fellow-citizens expressed in the subject I have chosen—"Making Friends of the Public". And this positive attitude should be shown not only by each employee but by each organized unit as expressed by the regulations laid down for the guidance of the employees. My aim is to show the necessity for such a mental outlook towards life, and the advantages gained by the employee and the employer and through them the larger neighbourhood of our municipalities, province and country.

The subject might be defined as a statement of the mutual advantages to employees, their employers and the whole circle of individuals with whom they come in contact in everyday business life when every word and deed of the employee is actuated by the desire to win friends for himself and for the economic unit of which he forms a part. The simplest statement is still the old-fashioned sentence—"Do unto others as you would have them do unto you". This involves above all else non-discriminatory, fair dealing with every individual consumer, whether he represents millions of dollars of investment and a monthly bill of thousands of dollars or the householder with a minimum bill each month.

In the first place, I shall endeavour to draw attention to some of the more outstanding advantages to the employees when they carry out their daily routine with this idea. Then I propose to mention why this attitude should continue to be an integral part of the policy of all utility companies, with special reference to the Province of Ontario and our Hydro organization. And lastly, I shall refer to some of the means that may be used in making a success of this plan.

Advantages to Employees

Since the inception of the Hydro movement—less than a quarter of a century ago, it has grown to a size that in many localities the work of a large number of the employees is purely of a routine nature. That is, their work has become so standardized that in many instances it consists of repetition of the same action as regularly as if the employee were operating a machine in a factory. The effect of such monotonous work

is well known. I have no doubt but that this industrial monotony is one of the main sources of unrest amongst staffs to-day, and the apparent lack of interest in anything pertaining to the work except the pay envelope.

There is a strong instinct in human nature that makes most people like to see the whole change in any product. This may partly explain the fact that most men retain their boyish desire to see the wheels turn round. The creative instinct was satisfied in the olden days when the craftsman completed the whole process of manufacture from the raw material to the finished product. But in these later days when division of labor has complete rule in the factory plans one man may do no more than guide a machine all day long that only punches out rivets of one standard size. To him the raw material of the plant is only the sheet of metal that enters the maw of the machine; the finished product is only a rivet, over which he has no control as to size or finish, as the whole operation is so automatic. How can he have any incentive to feel pride in the finished product of the factory?

The same is true of office routine where an employee is engaged the whole day in passing and noting similar forms and making changes in the records he is responsible for. Just what incentive is there for an ambitious employee wishing to develop himself mentally and become a better citizen of his country as well as improve his position with his firm, but whose whole time during business hours is devoted to the repetition of the same action? Can any one be surprised that his primary interest is the pay envelope and that at closing hour he is anxious to get out where he can meet those outside interests that provide a welcome change?

As a matter of experience I gain more satisfaction out of helping some consumer who is in difficulty than I receive out of clearing all of the ordinary routine matters that are considered and passed upon every day. This satisfaction is not diminished even if the consumer does not express any appreciation for receiving quick attention, but there is a surprisingly large number who will take the trouble to call up. And it forms one of the pleasures of answering the telephone. After having successfully helped some other person out of a difficulty one feels that he has begun to justify his existence on this old earth.

You men from the municipalities where the staffs are smaller and the employees are probably personally acquainted with nearly all the consumers in the area served may not appreciate this fact so well. When John Smith comes in to apply for a change in service there is a personal interest felt from knowing John Smith and something of his circumstances of life, also a pleasure that changed conditions have made it possible for him to improve his living habits such as moving to a larger house, or putting into use added electrical conveniences. Even if he comes in to make a complaint he realizes that he is talking to an acquaintance or friend and the attitude differs from his attitude when talking to a representative of what he may consider a "soulless corporation". But in the larger centres where each

consumer making such application or enquiry is merely another individual in the long chain that passes by day after day, the problem is definite and requires consideration. In such districts the analogy to factory production explains the working conditions. The employee does one portion of routine day in and day out for individuals who are only names and addresses—that is they have no real existence for him. You can imagine the monotony of such work, and what a relief it is to meet occasionally a familiar name or address. The problems of lateness, absenteeism, watching the clock become of larger importance to the executives in their endeavour to create a more vital interest on the part of the employees towards their work. Will not a continuous reminder that these unreal things such as names and addresses represent human beings as real as each one of us, and as anxiously meeting similar problems of life help to make the routine less of a mechanical nature? Will not an increase in the knowledge of the employee as to the part that his work occupies in the satisfaction gained by other human beings from the use of electric energy or any other comfort-giving device serve to quicken his interest in his everyday work? I leave this to you to consider as it is a question of policy and education to be solved by executives in accordance with the conditions existing with each staff.

Advantages to Organization

It might be reasonably asked why a utility distributing a commodity widely used and necessary should give special attention to win friendly feelings on the part of the public. And a company distributing electric energy may be considered in a particularly happy position as far as knowing there is a constant demand for its product. For certain uses of electricity there is no question whatever of substituting some other means to obtain a somewhat poorer result. Electricity is a necessity under our existing modern civilization, and practice has shown the advisability from an economic viewpoint of one distributor in each municipality. That is, the distributor enjoys a monopoly in the area for which he or the company is responsible.

However, that is a rather serious position for any firm or company. All individuals when purchasing goods or commodities wish to exercise their right to a choice of the place where they may go. With the distribution of electricity, as I have mentioned, this right is denied. There is only one place where the ordinary resident can go to obtain the supply of electric energy. And as a result there must be a certain latent yet natural feeling that he is not being allowed his proper right of making a choice. The utility must overcome this to have true friends amongst its consumers, and can do so only by a sustained policy and continued effort on the part of its employees.

One may further argue that especially with the Hydro organization in our Province of Ontario which operates under the unassailable condition of supply at cost and without profit, there is no doubt but it is in entire favour with the public. But there lies the danger—namely that we sit down, pat ourselves on the back and

congratulate one another on the wonderful success that has been attained—and while doing so overlook the opportunity to make friends that is right ahead of us. There is only one monopoly that is tolerated by the citizens of a democracy—the government with its control and taxing powers. That is a position which the Hydro should exert every effort to avoid. To be charged honestly and fairly with such an attitude towards the people of this Province would be failure—failure towards those who have striven in the past to build up an organization that will carefully attend to the needs of our communities, and failure to the great mass of the people who are putting their trust in us as honourably striving every day to make easier the toil of our speed-driven life. It is a part of the duty of every employee to do his share to prevent any such feeling and he must keep everlastingly at it.

Means of Contact

I have already referred in a general way to the favourable reaction that such an attitude will have on the employee himself. Let us now consider some of the methods by which friendliness may be secured and held.

There are three means through which the public meet the employees of our municipal systems—personal contact, telephones and correspondence. Each of these is important, but there is probably more advantage gained for a system through personal contact of its employees with the individuals of the public than through either of the other means. It is therefore necessary that special importance should be given to the choice and training of those who are called upon to meet our consumers. Each new employee must do his part in maintaining and building the reputation of the Hydro organization.

Courtesy

There is one quality above all others that each employee must use when meeting consumers—courtesy. Not merely formal courtesy such as one can train himself to use in his everyday business dealings is sufficient; one must have a really friendly courtesy that is shown in all dealings with everyone with whom he comes in contact — consumers, fellow-employees, all alike. The necessity for friendliness and courtesy has been repeated so often by all of those qualified to speak and write about making friends with the public that every one of us remembers, I am sure, the he has heard of it ever since he began his business career. But there is no harm in repetition as there may be some who in theory appreciate the value of this quality but in practice fail to live up to their theory. I would emphasize the feeling of friendliness, namely the desire to make and retain friends both for oneself and one's employer, as being equally important as courtesy. In fact, if we understand by the term only a formal courtesy without feeling a desire for friendliness we are harming our future relations with our people quite as much as if we were discourteous and neglectful.

There are three other qualifications I would like to point out as of importance to the individual meeting the public and representing our organization.

Appearance

Appearance is the first. The consumer judges the organization by the individual whom he meets. The employee must remember that he is the organization to the consumer and that he is pre-judged by his appearance and actions before he has even had an opportunity to speak.

This matter of appearance should also be applied to the properties that we are operating. We expect our employees to have pride in their personal appearance. How can we expect this if we are operating properties that show we take no pride in their appearance—rotting poles, dog-eared wires with the insulation hanging in strips, stations in old buildings cluttered up with waste that are dangerous as well as unsightly. If we are proud of the job we are doing and proud of the municipality we are serving why should we not keep up the appearance of our equipment so that it is a matter of pride to the residents of the municipality? This matter of appearance must also apply to our buildings. Is there not a feeling of satisfaction in looking at a well-constructed building of good appearance, considered with the district and properly serving its purpose, that helps to build up civic pride? Otherwise why would so many of our commercial institutions spend so lavishly on the appearance of their buildings—amounts which are paid for only from the profits on the goods sold? As engineers we must remember that we take one of the most beautiful things on this earth—a tree—strip from it all its attributes of beauty, branches and leaves, bring the bare stump to our streets and roads, hang on to this stump cross-arm on top of cross-arm, on which we string a maze of wires and every two or three poles we hang a mass of iron. When our work is finished we look at it and remark as to what a neat engineering job we have done. But we overlook the resentment of our fellow-citizens to this construction, resentment that cannot be overcome even by painstaking care and attention in other ways, such as continuity of service, regularity of voltage supply, prompt attention to interruptions and even rates.

Alertness

The second quality desirable for the employee is alertness. This may be described as the ability to "size up" the approaching visitor as to the most suitable means of greeting him. Also during the conversation the employee must be alert to the reactions of the other person to the course of the conversation. There are times when it may be desirable to change the subject for a few moments, and the person who is alert will grasp such an opportunity when he realizes the necessity. The quality of alertness is partly innate, but may be developed by using good judgment during one's ordinary work.

Adaptability

The third quality is adaptability. You may use other terms such as tact or diplomacy to express nearly the same meaning but these terms are much less positive in their attitude towards the other fellow. That is the employee being alert to the responsiveness of the consumer readily brings about some change that will enable him to continue on

friendly terms, and also reach his objective. The employee keeps in mind the general regulations of the organization towards the work he is doing, but he must use his own judgment, ingenuity and common sense in the method he uses when dealing with the consumer. Perhaps the following illustration of the method used in clearing up a complaint of a large bill, which was apparently about to develop rather seriously will explain this quality.

In this instance the consumer maintained that he could not possibly have used the amount that was billed, as the habits of the family were very regular, so that there should be very little difference between the bill in question and the bill for the same period of the previous year. The meter was tested for accuracy and test made for ground but everything proved O.K. The consumer still maintained that they did not use the amount and brought out the receipts of previous periods. The employee who called one evening in order to see the consumer personally on the premises took the bills, set down the amounts for similar periods for two years side by side. When the two lists were completed a glance showed him that there would not be much difference in the totals. But he suggested that he was slow at figures and asked the consumer to arrive at the totals himself. As the consumer was finishing the adding there came quite a change of expression over his face as his earlier words were borne out by the figures. The employee allowed the adding to be completed, then raised a question about a pet dog in the house and there resulted a friendly and animated conversation. Finally reverting to the complaint the employee referred to the bill previous to the bill which had been in dispute and which was much smaller than the bill for the corresponding period of the previous year, although there had been no report of this nor request for re-reading of the meter. The employee was able to suggest when leaving that the consumer must have enjoyed the proceedings throughout, as he remembered the small bill, yet insisted on all sorts of efforts to find out the reason for the large bill which he was disputing and the consumer rather agreed by his silence.

Telephone

In these modern days so much use is made of the telephone in business that mention should be made of the means by which use of the telephone can make friends for us. The two parties are not able to see each other so that the sense of hearing is the only means of contact between the two people taking part in the conversation. Therefore, an employee should be very careful to cultivate a pleasing speaking voice and also be careful as to the sense given to his words by varying changes of tone. He must be much more careful than when in personal contact, as a smile frequently changes completely the meaning taken from words, but again our telephone friends have not provided us with an instrument sensitive enough to hear a smile. Even the method of speaking is to be noted; one should be rather deliberate and speak directly into the mouthpiece. You all know from experience how exasperating it is to

hear only a succession of sounds too faint to make any meaning from them because the other party is looking over his shoulder or doing anything but speaking directly into the mouth-piece.

CORRESPONDENCE

Another method of making friends is by means of correspondence. Here there is no personal contact whatever, and the receiver has opportunity to read the letter at leisure so that he may study all the good points and bad points, if any. The letter should be clear and free from ambiguity of any kind. Care should be paid that there is nothing that can be twisted or interpreted by the most susceptible person in a way not intended. This is very true of correspondence dealing with complaints as it frequently happens that the consumer will not say that he is satisfied although he acknowledges that he has been convinced that the meter is registering correctly and appreciates that we depend upon the meter to render the monthly bill. But the inability to visualize a kilowatt-hour as one makes a mental picture of a gallon of water or a cubic foot makes it very difficult for a consumer to realize just what our employees are talking and writing about. The methods of the writers of successful letters form a study in themselves, a study that provides sufficient material for a separate paper. However, even the most successful word or phrase or letter should be subject to constant critical supervision.

CLEARANCE OF INDIVIDUAL TROUBLE

One more method that our organization uses to make friends should be mentioned. This is the service given our consumers in the replacement of blown fuses, and an endeavour to find the cause of the trouble and give advice to prevent a repetition of the trouble. The average householder is fairly ignorant of the purpose of the various gadgets at the service entrance and when he is in the midst of a happy party what is there more annoying than to have the lights go out? As a rule such a misfortune occurs at night and the householder feels particularly helpless as he is aware that the contractors are off duty too. What a relief there is to be able to call the supply company, have some one come within a few minutes and make the necessary replacement of fuses so that within a very short time all proceeds merrily again! The servicemen have been complimented repeatedly for their quickness in clearing up such troubles. There is no doubt that this policy has won for our Hydro organization much friendly feeling.

In order to keep this paper at a reasonable length I have only touched upon many topics in relationship to this broad subject. It has been my attempt to show that the way we treat the sensibilities of our consumers is just as important as the kind of service we give. In fact his demands as to service are more likely to be fair and reasonable provided he has been treated on a friendly basis. As some one has recently said—"If there exists any danger whatever of damage to Hydro it lies in losing touch with the public." It therefore behooves us as representatives of the Hydro organization to see that in all of our meetings with our consumers

and the public in every way we have the sense of our responsibilities combined with the desire to make friends for our organization. When this task has been well performed we shall have such a host of friends that no amount of hostile propaganda or criticism will prevail against the Hydro principle and our industry throughout our own Province.

Discussion

Mr. R. H. Starr, Orillia: I would like to ask Mr. Evans if they charge for the replacing of fuses, or if that service is free.

Mr. Evans: The practice in the City of Toronto is to replace a limited number of fuses without charge. Beyond that number a charge is made.

Mr. E. V. Buchanan, London: The most difficult problem, it seems to me, is the one where there has been a large consumption and where there is no apparent explanation for it, and the consumption has returned to normal. The consumer tells you that he did not use the power, and he sticks to his guns. I have not yet been able to find the answer to that consumer, he always goes away dissatisfied. I would like to have someone here give me a good answer for that man.

Perhaps the use of technical terms is not so serious to-day as it was some years ago, because the present generation have grown up among kilowatts and think they know what they are. But there has been a practice in England for many years of calling a kilowatt-hour a unit, and I have used that term on several occasions because I think it is much simpler. Although it does not mean anything, you can tell the customer that he consumed so many units this month, as against so many in another month, and it is not necessary to introduce the technical term "kilowatt-hour".

Mr. Starr asked about charges for fuses. In London we have been charging for every service that we render outside of the usual service in supplying current. We charge for replacing fuses. We charge for shutting off and turning on the lights if people are going away. When a consumer moves from one house to another we have a transfer charge of $1, and it has got our Commissioners into a whole lot of trouble. I would like to have some expression of opinion about the advisability of these charges.

Mr. G. G. Cousins, H.E.P.C. of Ont: In line with Mr. Buchanan's remarks regarding complaints of excessive charges, it has been found by a number of power companies that an automatic recorder of daylight intensity makes possible a comparison of the conditions which might influence the use of lamps. On a cloudy day the record shows a lower intensity of daylight, and the natural result is an increased use of artificial light. This increased use may account for an appreciable increase in the amount of power used by the consumer without his being aware of its magnitude.

Mr. H. F. Shearer, Welland: I think the charge for service to the consumer is in line with the general practice of the Hydro that the customer should pay for what he gets.

I do not see any reason why consumers as a whole should pay for the expense that one customer incurs when it is to his advantage to do so. We charge $1 for a transfer, and where fuses are burned out we make a minimum charge of 35 cents per call, with an added charge for any fuses supplied, exclusive of the main line fuses, which we maintain as part of the system.

Mr. Starr: We make no charge for transfers; the only charge we make to the customer is in case of a cut-off. We do not charge anything to cut him off, but we charge $1 to put him on the line again.

With regard to the fuses, we leave that matter to the contractor.

It is not always a man's fault when he moves, and nine times out of ten someone else moves into the house that he moves out of and it is just a case of changing the records.

Mr. Evans: Mr. Shearer says that they maintain the main line fuses. When the lights go out in a consumer's house, I do not just understand how they know whether the trouble is going to be one of the main fuses or a branch fuse, so probably a call will have to be made any way, and I can see that there is likely to be some difficulty.

Regarding the question of fuses again, I noticed not very long ago a report from a certain supply company in the United States, in which it was stated that it was the custom there to discourage the replacement of fuses by customers. This guarded against over-fusing and enabled them to determine the exact cause of the trouble and to assure the customer of continuity of service in the future.

I have no panacea at all for Mr. Buchanan in regard to satisfying the customer in connection with the bill. There are certain customers who, under any circumstances, would complain about a bill. One can only point out to them as courteously as possible, having first tested the meter, that the meter is accurate and that we depend upon it to register the amount of energy used. As a final resort we tell him that if he is not satisfied he can have the meter tested by the government, and that if they find it is not accurate within the limit allowed, the cost of the test will be paid by the supply company, or if it is accurate, by him.

Mr. Shearer: We have no difficulty in regard to the charges made for fusing. If there are fuses supplied we take the signature of the consumer acknowledging that the fuses were supplied, and they are charged on his next bill.

Mr. Evans: My point is that you have to make the call anyway; therefore you have to maintain your organization.

Mr. C. E. Kirkby, Stamford Twp.: We have water of a very high lime content. When we find a water heater that has not been cleaned out why should we not send out and perform the service that the gas company is performing?

Mr. Buchanan: A great deal of the trouble in some of these matters is due to the fact that the policy of doing business in an organization such as ours is so radically different from that of a private corporation. The basic principle of the distribution of hydro-electric power, as stated in the Act — and I assume it applies to other

utilities where publicly owned — is that the service is at cost, and I always take that to mean service at cost to each and every individual consumer. That, therefore, is the logical justification for making these various charges.

On the other hand, a private corporation, no matter what it may say, makes its rates on the basis of what the traffic will bear, or on expediency; and on the same basis of expediency service is rendered. Should we discourage this very rigid policy of service at cost and follow the practice of some of these companies and give this service for the sake of making friends with the public?

I might say to our friend from Stamford that he might overcome his difficulty with regard to water heaters if he would do what the London Hydro is doing — sell the consumer a water-softener.

Mr. Phelps: The discussion has brought out the fact that probably we should have some uniformity in billing the public, as to the replacement of fuses and other services rendered. It leaves a bad taste in your mouth when someone comes into your office and tells you that he can get this service for nothing in Toronto and wants to know why you charge for it here. I think we should try to work out some uniform practice.

I think that when we render a service we should ask the people to pay for it. There is no money to be made in giving things away.

HYDRO NEWS ITEMS

Eastern System

On January 26th, the village of Westport passed by-laws authorizing the securing of a supply of power from the Commission, and the raising of $15,000 in debentures to provide for a distribution system. The village will be connected up with the Rideau district lines at Perth, and service will also be made available to rural residents in the vicinity between Perth and Westport.

* * * *

General

In view of the increased interest in mechanical billing equipment it might well be to note the following information:—

There were forty-two machines in operation up to the 20th January, 1931, in various municipalities. These have been placed in operation as here stated,—

Up to and including 31st December, 1929 — 16.

Up to and including 31st December, 1930 — 36.

Electric Bulb Still Works: Bought in 1902

A unique performance for an electric light bulb has been brought to notice by Gregory Thomas, 22 Vernon Street. June 5, 1902, Mr. Thomas bought the bulb from the Maritime Electric Company, for thirty-five cents and since that time it has been burning steadily, 9 hours a day. It is estimated that the bulb has been lighted 92,029 hours, which is no mean performance for a thirty-five cent light. At the present time the electric light is in good condition and shows no signs of deterioration. Mr. Thomas thinks it might keep going for another 28 years. The performance is the more outstanding due to the fact that the light has been frequently switched on and off, which tends to put more wear on it than otherwise.

During its 28 years of service the bulb has been in two different locations. From 1902 up until the time the old Majestic Theatre was torn down the bulb remained there, and since that time it has been in the house of Mr. Thomas.

—*Halifax Herald.*

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*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BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Loans to Rural Consumers

AN Act was passed at the last session of the Ontario Legislature to provide for granting aid toward the installation of electrical works in rural power districts. It may be briefly summarized as follows:

A sum of Two Million Dollars has been set apart out of the Consolidated Revenue Fund of the Province of Ontario for the purpose, and out of this advances are to be made to the Commission from time to time as required. Regulations authorized by the Lieutenant-Governor-in-Council prescribe the terms and conditions on which advances are to be made and the Act administered.

Subject to the regulations, the installation in respect of which aid may be granted under the Act shall include:

(A) Wiring from the transmission or distribution lines of the Commission into and throughout dwellings, barns, out-houses and any other works that may from time to time be specified in the regulations made under the authority of this Act.

(B) Such transformers, motors and other appliances as may be necessary or expedient for any agricultural or domestic purpose or which may be specified in the regulations.

A consumer who has signed a contract for a supply of Hydro power, if he is the owner of the premises which he is occupying, and can give satisfactory references as to credit and financial status, may make application to the Commission for a loan. Each application shall be accompanied by a statement of all encumbrances against the applicant or his property, registered or otherwise. If these encumbrances are not serious the application may be favourably considered.

In no case shall a loan be made in excess of one thousand dollars to any one owner. All such loans shall be repayable with interest at the rate of six per cent. per annum in equal periodic instalments of principal and interest within a period not exceeding twenty years. This limit of twenty years is not intended to be the usual length of time but the maximum.

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The type of equipment and the condition of the farm buildings govern the length of time for which a loan will be granted. The more perishable the equipment, the shorter the period, and in very few cases would a loan for a period of more than ten years be justified.

Under the regulations a loan may be granted for the following purposes:

(A) The erection of service line from roadway to the meter located on the farmer's premises;

(B) Wiring of dwelling

(C) Wiring of barn;

(D) Wiring of other buildings;

(E) Purchase and installation of utility motor;

(F) Purchase and installation of grain grinder;

(G) Purchase and installation of pumping equipment;

(H) Purchase and installation of milking machine;

(I) Purchase and installation of electric washing machine.

(J) Any other works and appliances within the purposes set out in the Act as the Commission may from time to time determine.

When a consumer desires to make application for a loan the procedure may be briefly described as follows:

The applicant makes enquiries from the local representative of the Commission and receives a Preliminary Application Form. On this form is to be indicated the amount of wiring, if any, which is to be done, with an estimate of its cost, also an estimate of the cost installed of any equipment which the applicant desires to purchase. On the form is also to be shown all the encumbrances against the applicant or property, whether registered or not. After the Preliminary Application for Loan has been approved by the Commission, the applicant is notified of such approval.

If requested by the applicant, the field representative of the Commission will assist the applicant as far as possible in securing prices for wiring and for electrical equipment. In order to facilitate this work a Wiring Specification Form is available upon which the Commission representative can make a wiring lay-out of the premises for submission by the applicant to wiring contractors for tender. Upon request, also, the Commission representative will give the applicant information as to the type of equipment suited for his requirements. The applicant himself makes the contracts for wiring and for the purchase of equipment authorized in the application. When the wiring has been done and the equipment purchased and installed, the Commission representative will make a final inspection thereof and secure from the applicant copies of the paid bills indicating that everything has been properly

installed and paid for. These paid bills will be submitted to Head Office along with the final certificate of the representative. If all the requirements of the Act and the regulations are complied with a loan corresponding to the amount in the final certificate will be made to the applicant.

Before the money is advanced, the applicant must furnish to the Commission a Loan Contract Form under which the property purchased and installed is vested in the Commission. Notice of the loan is finally registered in the Registry Office against the land of the applicant for the Commission's protection.

This rural loan scheme has been in operation for some time. Quite a number of applications have been received and approved and a number of loans have been granted, and there is every indication that this method of financing the installation of Hydro service in rural districts will become popular among Hydro rural consumers.

Hydro-Electric Progress in Canada in 1930

WATER power development, both in the construction of new plants and the extension of existing ones, was maintained at a high level throughout the Dominion during 1930. That practically every province was represented in these activities is disclosed by a review prepared by the Dominion Water Power and Hydrometric Bureau of the Department of the Interior.

New installations brought into operation during 1930 aggregated 397,850 horse-power, bringing the total installation for the whole Dominion to a figure of 6,125,000 horse-power at the end of the year. Construction is active, also on a number of undertakings throughout the country, several of which are of outstanding magnitude and with the completion of these during the next two or three years, more than 1,500,000 horse-power will be added to the Dominion's total. Other important projects are under active investigation with development apparently imminent in several cases, while plants recently placed in operation or actively under construction are designed for future extensions as load conditions warrant.

This large programme of construction which involved a probable expenditure of $80,000,000 during the year just past, and will involve as much as $300,000,000 during the next two or three years, has had and will continue to have a very important influence on employment conditions throughout the Dominion. It is estimated that more than 11,000 men are at present employed on the actual construction of these various developments while several times as many are given employment in manufacturing and other establishments providing material and equipment going into the works.

During the year Ontario led in new installations placed in operation

with a total of 136,000 horse-power followed by Quebec with 122,700 horse-power, British Columbia 71,000, Saskatchewan 42,000, New Brunswick 21,000 and Nova Scotia 5,100. Large undertakings are at present under construction in Quebec, Ontario, Manitoba, and British Columbia.

In British Columbia, in addition to the work completed, other projects were actively prosecuted, involving initial installations totalling over 136,000 horse-power, while other large undertakings are in immediate prospect.

Construction under way in Manitoba will provide initial installations of 40,000 horse-power under partial head at the Seven Sisters site on the Winnipeg river, where the ultimate development will comprise 6 units of 37,500 horse-power each operating under a head of 66 feet. At Slave Falls plant on the same river, designed for an ultimate capacity of eight units of 12,000 horse-power each, two such units will comprise the initial installation. It is expected to have both of these plants in operation during 1931.

The total power in undertakings under way in Ontario involves installations aggregating 442,000 horse-power. This is made up of the Commission's share of the 224,000 horse-power under development at Chats Falls on the Ottawa river and the 330,000 horse-power development of the Ontario Power Service Corporation, Limited on the Abitibi river.

Plants under active construction in Quebec involve an initial installation of 805,000 horse-power and a final installed capacity of 2,013,000 horse-power. These plants are practically all of large capacity, including Beauharnois on the St. Lawrence, Rapide Blanc on the St. Maurice, Chute-a-Caron on the Saguenay and Chats Falls on the Ottawa.

Farewell to Mr. Magrath

On the evening of February 26, the executive staff and department heads of the Commission tendered a farewell dinner to Mr. C. A. Magrath, and presented him with an illuminated address. Letters of appreciation from Mr. and Mrs. Magrath are reproduced herewith as also pictures of the address.

* * * *

Toronto, February 27th, 1931

Dear Mr. Pope:

You can readily understand that I was under quite a strain last night, knowing that the event meant, in some measure, a breach in the close relationship that has existed for over five years between myself and members of the staff and other officials of "hydro."

I have no words to adequately express myself about the extraordinary kindness shown to me last night by yourself and associates.

Please convey to them my heartfelt thanks for their loyal co-operation during my chairmanship.

With kind regards,
Believe me,
Yours sincerely,
(Sgd.) C. A. MAGRATH.

W. W. Pope, Esq.,
190 University Avenue,
Toronto, Ont.

* * * *

Toronto, February 27th, 1931

Dear Mr. Pierdon:

I am quite conscious of the fact that I utterly failed last night to properly express my deep gratitude to you and your associates for the tribute you paid me.

As for that magnificent present—well, I must admit I am quite unworthy of it, and the generous statements made about myself.

I have such faith in the loyalty of all those who are carrying on the work of "Hydro" that they have acquired by the length and character of their service, to appropriate that motto—"Pull, pull together, in all kinds of weather." This is exactly what you are all doing.

With kind regards and best wishes, believe me,

Yours sincerely,
(Sgd.) C. A. MAGRATH.

W. G. Pierdon, Esq.,
190 University Avenue,
Toronto, Ont.

* * * *

398 Wilbrod Street,
Ottawa, March 1st, 1931.

Dear Mr. Pope:

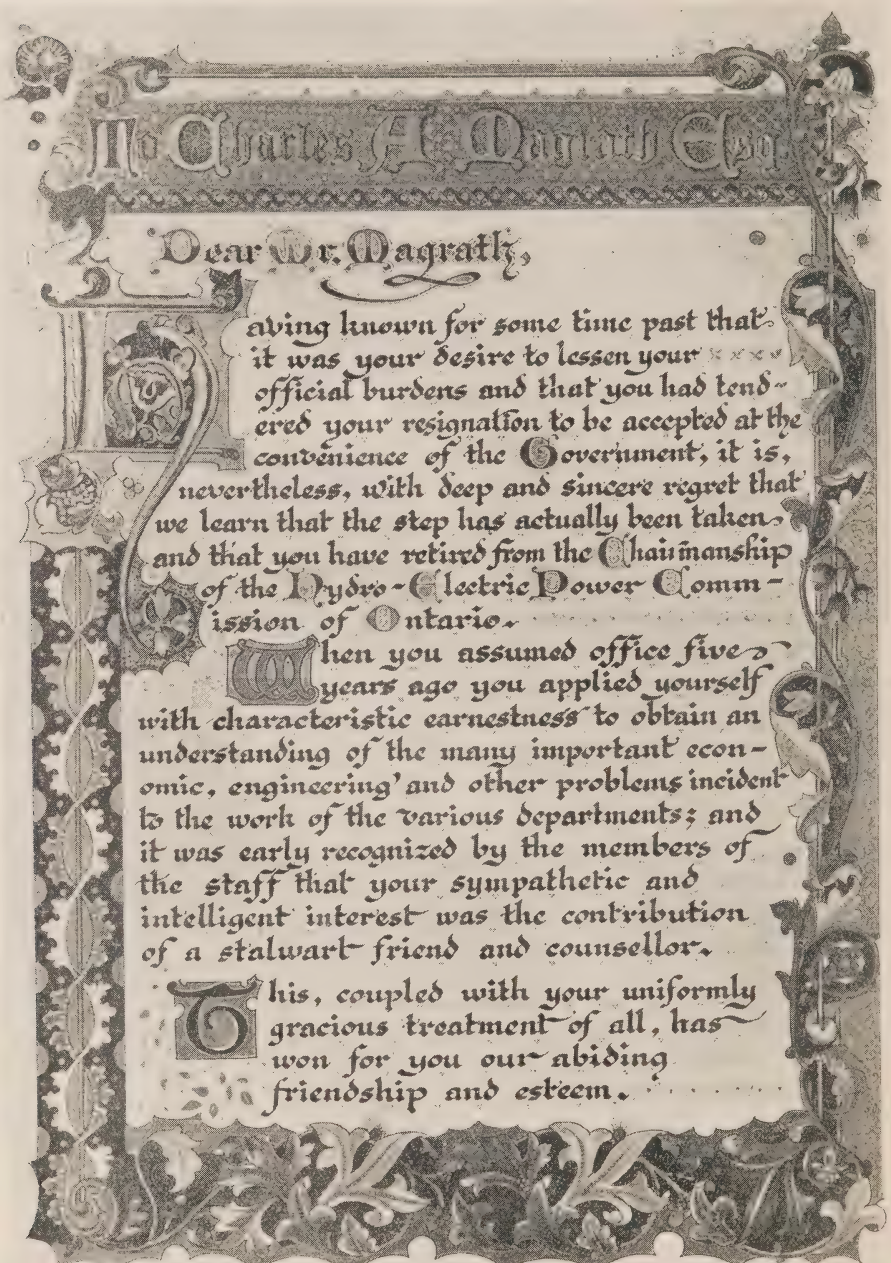
My daughter and I were more gratified than words can express at your remembrance of us on the occasion of the banquet to my husband. The roses are very lovely, and the beautifully illuminated card accompanying them I shall always cherish.

My husband was deeply touched by the tributes to him. Never have I seen such very handsome comports, so exquisitely designed, and the presentation book is really beautiful.

He feels very sad at parting from all his associates and we shall always look back with pleasure to our years in Toronto.

I hope you will convey to the staff our thanks and deep appreciation of your thinking of us at home on such a memorable occasion.

Very sincerely yours,
(Sgd.) MABEL MAGRATH.



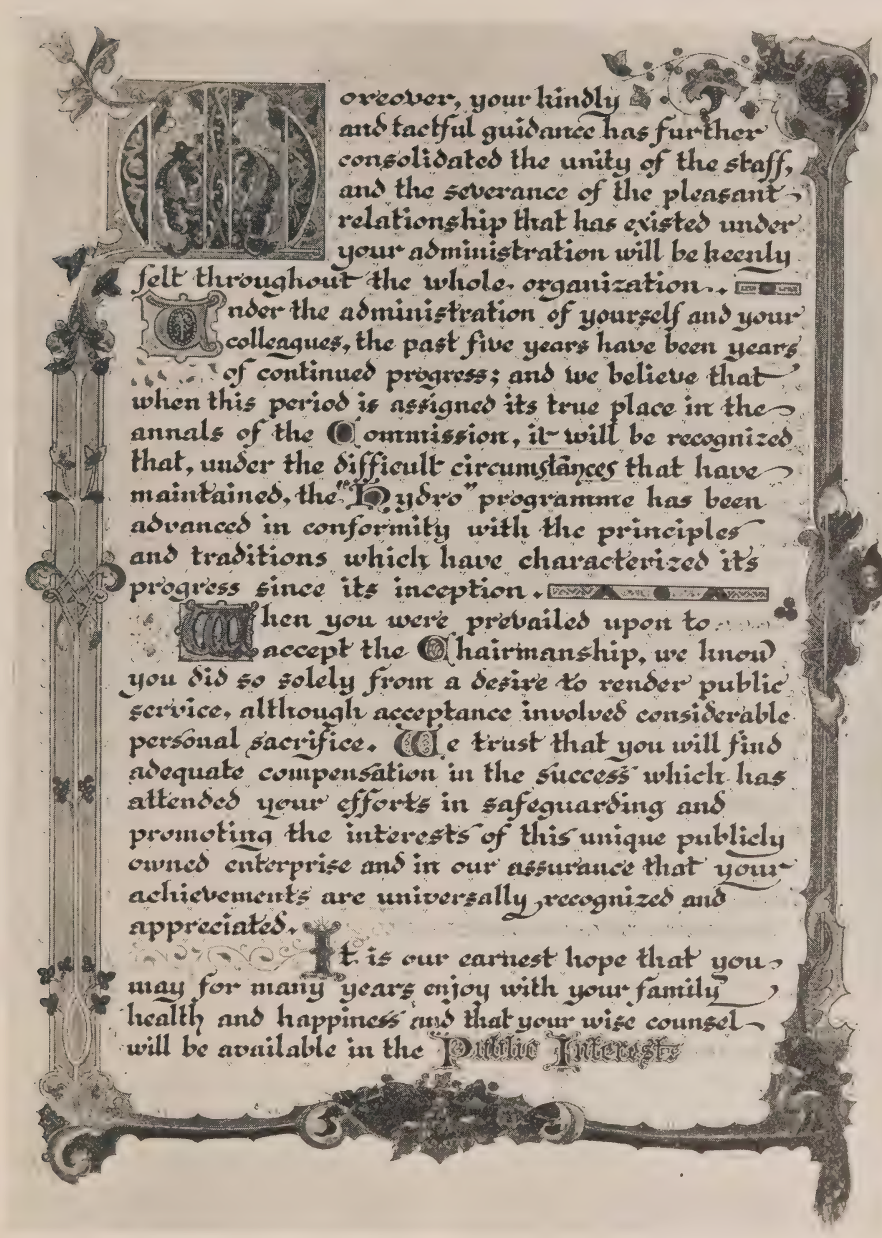
To Charles A. Magrath Esq.

Dear Mr. Magrath,

Having known for some time past that it was your desire to lessen your official burdens and that you had tendered your resignation to be accepted at the convenience of the Government, it is, nevertheless, with deep and sincere regret that we learn that the step has actually been taken and that you have retired from the Chairmanship of the Hydro-Electric Power Commission of Ontario.

When you assumed office five years ago you applied yourself with characteristic earnestness to obtain an understanding of the many important economic, engineering and other problems incident to the work of the various departments; and it was early recognized by the members of the staff that your sympathetic and intelligent interest was the contribution of a stalwart friend and counsellor.

This, coupled with your uniformly gracious treatment of all, has won for you our abiding friendship and esteem.



Moreover, your kindly and tactful guidance has further consolidated the unity of the staff, and the severance of the pleasant relationship that has existed under your administration will be keenly felt throughout the whole organization.

Under the administration of yourself and your colleagues, the past five years have been years of continued progress; and we believe that when this period is assigned its true place in the annals of the Commission, it will be recognized that, under the difficult circumstances that have maintained, the "Hydro" programme has been advanced in conformity with the principles and traditions which have characterized its progress since its inception.

When you were prevailed upon to accept the Chairmanship, we knew you did so solely from a desire to render public service, although acceptance involved considerable personal sacrifice. We trust that you will find adequate compensation in the success which has attended your efforts in safeguarding and promoting the interests of this unique publicly owned enterprise and in our assurance that your achievements are universally recognized and appreciated.

It is our earnest hope that you may for many years enjoy with your family health and happiness and that your wise counsel will be available in the Public Interest.

Illuminated Address presented to Mr. C. A. Magrath

Public Utilities Reduce Radio Interference

By H. O. Merriman, B.A. Sc., Engineer in Charge, Interference Section, Radio Branch Department of Marine, Ottawa.

(Presented before Association of Municipal Electrical Utilities, at Toronto, January 9, 1931.)

Relations With The Public

CLOSE co-operation between the electrical industry, the radio industry and the broadcast listeners is absolutely necessary for the reduction of electrical interference with radio reception.

The attitude of the manufacturers of electrical apparatus and the distributors of electrical energy has changed considerably in the last few years, as they now realize that it is very necessary to consider the possibility of their lines and apparatus causing radio interference. Many manufacturers have changed the design of their apparatus in order to reduce interference, and advertisements frequently include, as one of their important features, the statement that the apparatus concerned will not cause radio interference. Manufacturers of oil burning furnaces were among the first to make this change and many manufacturers of household appliances have substituted types of electric motors which cause no interference, in place of the commutator motors previously supplied. Some manufacturers go so far as to guarantee their products against radio interference (for instance certain distributors of electric warming pads), and will replace any pad found to produce radio interference.

Many electrical organizations are now financially interested in the sale of radio receivers and have, therefore, an added interest in the reduction of interference.

Distributors of electrical energy, who are not interested in the sale of radio receivers, also find that there is a considerable direct financial return for their work of improving reception conditions, over and above the question of the good will of their consumers. Actual figures have shown that the introduction of a radio receiver into the home increases, to a considerable extent, the consumption of electrical energy. The actual energy consumed by the radio receiver of the electric type, or that consumed in charging batteries, is very small, but it is found that the increase in the lighting and heating load is quite an item. The National Electric Light Association has estimated that, in some districts, this increase amounted to 20 per cent. of the total load.

Regulations to Enforce the Suppression of Interference

In many places throughout Ontario there has been considerable agitation to enact by-laws to compel the owners of interfering apparatus to suppress the interference. I believe by-laws have been passed in St. Thomas, Brockville and Orangeville, with the

result that a number of flashing signs and other types of interfering equipment have been successfully dealt with. It is, however, particularly desirable that unreasonable regulations and laws impossible to enforce should not be placed on the statute books in Canada. In a foreign country a number of state and municipal laws and by-laws have been enacted, apparently as the result of a campaign conducted by a commercial firm selling interference suppression devices, and many of these regulations would appear difficult to enforce.

The question of incorporating the matter of radio interference in future editions of Electrical Codes has been brought to the attention of the Canadian Engineering Standards Association.

Practically all distributors of electrical energy have some means of dealing with reports of radio interference from their consumers. In the United States, where the government does not maintain a special service to investigate radio interference, some of the public utilities have developed elaborate organizations. In Canada, however, the public utilities are working in close co-operation with the government radio inspectors. Some of the Canadian utilities employ electricians who devote their whole time to investigating radio interference reported to be radiating from or originating on the utilities' lines or apparatus. The British Columbia Electric Railway Company employs an electrician who devotes part of his time to independent investigations and the remainder to accompanying the radio inspector in Vancouver and on tour throughout the district served by the B. C. Electric Railway Company. I believe that the City of Port Arthur also employs a radio interference investigator. Many other utilities in Canada have appointed one of their staff to investigate interference and arrange for the necessary co-operation with the government radio inspector.

Causes of Radio Interference

Radio interference is usually due to an electric surge caused by a spark somewhere on the electric system. This surge may represent an extremely small amount of energy, the current of the surge being, perhaps, less than a micro-ampere and the duration a very small fraction of a micro-second. It is on account of these extremely small quantities, which have an important bearing on radio interference, that electricians who are accustomed to dealing with power problems find difficulty in appreciating the importance of certain conditions which may cause interference. Radio interference, caused by a spark of charging current from a conductor to some insulated metal, such as a cross arm brace on a dry pole, may be greater than the interference from a grounded line. It, therefore, cannot be said that there is no fault causing radio interference on the line because the ground indicators show the line free from grounds. Another source of radio interference often more difficult for the electrician accustomed to power problems to appreciate is a discharge from high voltage conductors to insulators in perfect condition. Very widespread interference has been traced to a discharge from a high

voltage conductor to a bushing, where the bushing formed a perfect insulator, but the conductor was not in intimate contact with the surface of the bushing and a spark occurred from the conductor, through the air, to the interior surface of the bushing. This interference was eliminated by filling the bushing with a compound dielectric, capacity of which was somewhat similar to that of porcelain, and, thus, preventing any sparking of charging current through air.

Every conductor carrying electrical energy is surrounded by three fields of influence :—

1.—*The Electromagnetic Field*, which varies according to the current in the conductor.

2.—*The Electrostatic Field*, which varies with the voltage. These two fields of influence will only affect radio receivers whose aerials are in close proximity to the conductor and it is usually possible to avoid the interference by increasing the distance between the radio receiver and the power conductors. Where the receiving aerial is in close proximity to high voltage transmission lines, the aerial may be within the electrostatic field of the line. The voltage induced in the aerial can, in this case, be drained to ground through a choke coil connected from aerial to ground, which will offer very little impedance to the low frequency currents and, at the same time, not reduce the strength of the radio signals which it is desired to receive. Such a coil is usually installed in commercial radio receivers but, where the aerial is insulated from ground by a condenser, a drainage coil will very often reduce this type of interference.

3.—The third type of field surrounding the conductor is called the *Field of Electric Radiation*. There is very little radiation from circuits at frequencies used for the transmission of power, or even from the harmonics of such frequencies, but there is considerable radiation from any oscillations which may occur on the line at radio frequency or from surges of steep wavefront, as the steep wavefront of a surge corresponds to one-quarter of a cycle of very high frequency. The Field of Electric Radiation extends a considerably greater distance from the conductors than the electromagnetic or electrostatic fields, but seldom extends further than one-quarter of a mile from the power lines, unless the surge be induced on to other wires, in which case it may be carried by these secondary wires many miles and, thus, affect receivers remote from the power line where the interference originates.

The distance the surge will carry along a wire depends on the characteristics of both the surge and the conductor. Radio interfering surges will carry a greater distance along high tension lines or trolley wires than along the distribution system, as the transformers connected to the distribution system provide a capacity path whereby the surge is drained to ground, similar to the effect of condensers, which, as will be described later, are frequently used to reduce radio interference.

The amount of interference caused by a surge depends more on the time characteristics of the surge than on the voltage. It is found that surges of steep wavefront usually cause more interference than surges of sloping

wavefront, due to the fact that there is greater radiation from the former. The interference is usually caused by what is known as shock excitation to the radio receiver and the time elapsing between the commencement of the surge and the instant the voltage returns to practically normal, compared with the time of one-half cycle of the radio frequency to which the receiver is tuned, has a considerable bearing on the resultant interference.

Investigation of Radio Interference: Questionnaire

The investigation of radio interference commences with a report from a broadcast listener. Questionnaires filled out by the broadcast listeners, giving a number of details of the type of set and particulars of the interference, have been tried with varying degrees of success. Some of the public utilities in the United States require a fairly elaborate questionnaire form to be filled in before they commence an investigation. It has been our experience, however, that very little technical information can be obtained by means of the questionnaire from the broadcast listener, on account of the difficulty of describing the peculiarities of the interference in such a way as to be of any material help in the investigation. The questionnaire forms, however, may be useful to suggest to the complainant certain tests which he may carry out to determine the origin of the noise heard in the radio receiver. We have found it best for the investigator to get in touch with the complainant by telephone or by a personal call, and note any useful information, which the broadcast listener can give, on a simple card. A complete record of the case is then kept on the back of the card until the completion of the investigation.

The investigator should endeavour to determine if the noise is caused by atmospheric static, a defect in the receiver, some defective electrical apparatus in the same house or inductive interference from outside.

Radio Receiver

In this connection we would like to see more practical co-operation between the radio dealers and interference investigators. Unfortunately, some high pressure radio salesmen give their prospective purchasers to understand that any noise they hear in the radio receiver is due to some electrical fault which the owners of the electric lines or the Government will, on request, rectify. An analogy has been made in a way which may be very clearly understood, by comparing a supersensitive radio receiver in a city to a high speed automobile in dense traffic. The owner of the automobile does not complain to all concerned, after purchasing a car guaranteed to travel at seventy miles an hour, if he is not able to average this speed through city traffic or over bad roads. The owner of a supersensitive receiver should, therefore, use the reserve sensitivity in receiving distant broadcast stations only when reception conditions are particularly favourable.

A number of cases have been brought to our attention where noise was found to be caused by defects in the radio receiver, and, frequently, radio service men and dealers stated that this interference was due to

outside sources. Usually, cases of this kind cause considerable dissatisfaction to the broadcast listener and this reflects adversely on the radio dealers concerned. It is, therefore, felt that a more friendly co-operation between the radio dealers and the public utilities would be mutually beneficial.

AERIAL

The installation of radio receivers including the aerial and ground, has a considerable bearing on the amount of interference which will be received from power lines.

When the interference is caused by the normal operation of the utlities' lines, a reduction in the noise level can usually be obtained by reducing the coupling between the radio receiving circuit and the power or communication lines carrying the interference. This can be most economically done by making the necessary changes in the radio receiving circuit and removing the wiring of portable electric equipment from the vicinity of the radio receiver.

Interference can frequently be very much reduced by alterations in the location of the aerial, lead-in, or ground connection to the receiver. This is more particularly true where the interference is caused by the operation of street cars, as this type of interference does not usually extend as far from the trolley lines as the radiation of interference from power lines.

Many broadcast listeners living on a street car line have improved their reception conditions by moving the radio from the front of the house to one of the back rooms and installing the aerial and lead-in as far as possible from the service wire and all house lighting wiring. The aerial should be kept as far as possible away from the car line, even if this necessitates reducing the length of the horizontal part. Where there is a choice of location, it is best to avoid having the aerial parallel to the trolley line or feeders; in many cases a vertical aerial is found best. A horizontal top section may increase the signal pick-up, but, the relative increase in the noise level may be greater. On the other hand, where it is possible to erect a long, flat-topped aerial remote from power wires, reception conditions will, generally speaking, be improved, as the increased pick-up of the receiver will permit operation with a less sensitive setting of the volume control. A separate ground for the radio receiver, consisting of a driven rod or pipe, may be found better than connecting the receiver to a water pipe, as there is frequently induction from the power wires to the piping system in a building.

In some cases, interference has been found to reach the receiver by varying ground potential caused by the return railway current, and this effect has been reduced by using a counterpoise instead of a ground for the radio receiver.

Shielded leads-in have been used with varying degrees of success, but, in the present state of the art, it is difficult to predict what results may be expected in any specific case. It is sometimes possible to install an aerial in some location where the intensity of the interference field is very much less than in the vicinity of the lead-in. The greatest disadvantage of the

shielded lead-in is due to the electrostatic capacity between the conductor and shield, which forms a by-pass for the radio signal from aerial to ground, thus, considerably reducing the overall sensitivity of the receiver. This disadvantage may be partly overcome by reducing this capacity to a very low value, or by using the capacity in some tuned circuit. A type of shielded lead-in, which has given fairly satisfactory results in many cases, consists of a three-inch, sheet metal pipe, with a rubber insulated wire running down the centre and spaced from the sides by discs of cardboard fixed to the wire by means of friction tape, about every two feet. A shielded lead-in of lead covered, rubber insulated wire, is used to connect the radio receiver to the lower end of this pipe. It is important that the shield should continue to within an inch or two of the aerial terminal on the receiver. The shield should be grounded at one or more points and it may be found better to use a separate ground from that used for the receiving circuit.

Static

Interference due to atmospheric static can usually be recognized immediately by an experienced investigator, although it is difficult to describe the difference between noise caused by static and that caused by interference.

House Wiring

When it is found that the noise is caused by inductive interference, the investigator should test the local circuits for faults such as lamps loose in their sockets, defective switches, plugs to portable apparatus, or fuses, etc. Various circuits in the house may be switched off or opened at the fuses and any wiring to portable apparatus may be shaken, in order to cause any defect to give an indication in the radio receiver.

Patrol

When it is determined that interference is caused by some outside source, the district should be patrolled with a portable radio receiver in an endeavour to determine the wires responsible for the maximum radiation, and, also, the location of the maximum interference. The circuit from which maximum radiation is noted may not always be directly connected with the source, as the interference may be induced from one system of wires to another and carried greater distances on the secondary system than on the lines on which the source occurs. Similarly the point of greatest intensity on the circuit of origin may not be the actual location of the source of trouble. When patrolling along the power line, the intensity of the interference varies considerably, due to the characteristics of the power line affecting the radiation of the surge, and, also, to the varying coupling between the radio receiver and power line. The interference is greater on the radio patrol receiver when close to a pole having a ground wire, or passing under low strung service wires. Care should, also, be taken to avoid assuming that the source of interference is within a given district after finding that the interference decreases as one leaves this district, as quiet zones may be encountered and beyond these the interference may again

become apparent. Before commencing a detailed investigation, therefore, the patrol should be extended a considerable distance in all directions

Switching Test

When it is suspected that interference is caused by some industrial apparatus, the simplest way of locating the exact source is by means of a switching test which should be conducted at some mutually convenient time. The broadcast listener can often give useful information by reporting the times at which the interference starts and stops; and this may be connected with the time of turning on and off the street lights, or the operation of some electric equipment.

Tests should be repeated a number of times to avoid misleading results due to the interference starting and stopping from some unknown cause at the instant the switch is operated during the test. Observations taken on opening the switch, when the interference is continuous, are more reliable than those taken on closing the switch, as very often interference will not start the instant the faulty circuit is closed.

In carrying out these tests, it is not sufficient to stop the flow of current by opening a single pole switch, as interference is usually produced by the voltage on the line and not by the flow of current. It is, therefore, necessary to ensure that the voltage of the line under investigation be brought to zero.

High voltage power lines have been tested by disconnecting them entirely from the source of supply, but, due to the fact that they parallelled other high voltage lines, they remained at high potential by induction and the interference continued. In order to reduce the potential on such lines to zero, they should be grounded, and at several points, if found necessary.

Mallet Test

When it is suspected that interference is caused by some fault on the overhead distribution system, such as defective cutouts or accidental line contacts, the transformer poles in the district may be tapped with a five pound wooden mallet, and the vibration thus produced will cause the interference to start, stop or vary in intensity. The small amount of vibration required to give this response is remarkable. Very often a slight tap of the hand on a large wooden pole is sufficient. When the mallet is used to strike a pole, the vibration will travel a considerable distance along the power wires and affect a fault, in some cases, seven hundred feet from where the pole is struck.

Time Test

If the interference is affected instantaneously with the tapping of the pole, the immediate vicinity should then be inspected for possible faults, but, if a short time elapses, even a fraction of a second, between the tapping of the pole and the response in the radio receiver, the fault will likely be found a considerable distance along the line, as the interval corresponds to the time taken for the vibration to travel along the line.

Shaking Guy-Wires

Most types of faults will be affected by the sudden vibration produced by tapping a pole. Such faults are very

often intermittent and are affected by the vibration of passing traffic. Other types of faults, however, where the wires at the fault are normally a short distance apart, may be affected more by wind or the shaking of guy-wires than by the vibration due to the tapping of the pole. It is often possible to affect a fault which is a half-mile distant from the guy-wire being shaken. The time test may also be applied in this case, and interfering faults have been found a considerable distance from the point where the shaking of the guy-wire gave the first indication in the radio receiver.

Bamboo Pole

A bamboo pole may be used to shake individual wires and, thus, the source of the interference may be exactly located after the mallet test has indicated the pole on which the fault occurs. The bamboo pole may, also, be used by linemen to temporarily separate wires in accidental contact.

Warning

As radio interference very often indicates a fault, the radio investigator should wear gloves or use a dry wooden stick when shaking guy-wires, and, when tapping the pole with a mallet, he should stand clear of cut-outs or other apparatus on the pole, which might be in a dangerously loose condition.

Fuse Test

If it is suspected that certain metal is at high voltage above ground, for instance the ungrounded frame of a machine or ungrounded transformer case, a test may be made by connecting the suspected metal to ground through a fuse.

To carry out these tests, a connection is made from the suspected metal, by means of a sharp point on an insulated stick to a fuse enclosed in a fibre tube about three feet long. The fuse arrangement should be suitable for the highest voltage of the system to which it is connected.

Quenched Gap Test

One method of determining if a conductor, pole line hardware or other metal, is at high potential above ground is to bring some ungrounded metal near to it. If the potential is sufficiently high, one thousand volts or more, a charging current will spark to the metal.

On the 2,200 volt distribution system, a lineman, wearing rubber gloves, may make this test with pliers or a screwdriver, and the spark may be seen if the light is not too intense, and heard if other noises are not too great. When using a portable receiver, a click will be heard in the head 'phones corresponding to this spark.

The quenched gap testing stick is more satisfactory for carrying out these tests. This testing outfit consists of an insulating stick having at upper end, a sharp point for making contact through the paint, corrosion, or other coating. This metal point is electrically connected to a quenched gap consisting of a series of copper discs separated by mica washers, and the other end of the gap is connected to an insulated counterpoise, one or two feet long. The thickness of the mica washers may be adjusted to suit the voltage of the line under test. When the voltage to which the point

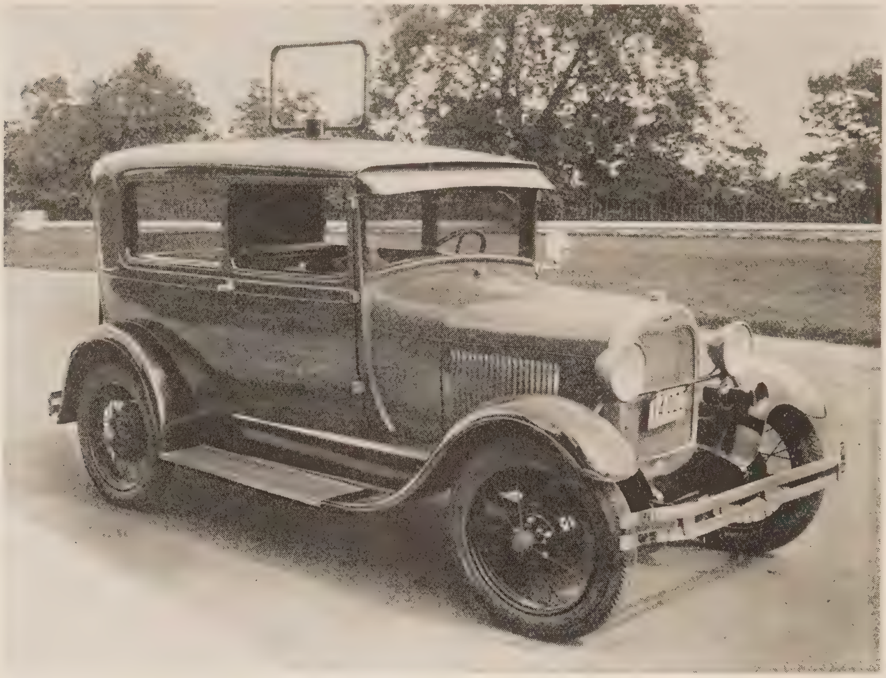


Fig. 1—Government Interference Car.

Fig. 2—Interior, Interference Car

of the stick is connected is sufficiently high above ground a spark will jump across the gap, charging the counterpoise and, thus, causing a definite indication on the portable radio receiver

Probe Antenna

The probe antenna is used to determine which of a number of wires, in close proximity, carries the greatest interference. This probe antenna consists of an insulated conductor enclosed in a tubular metallic shield extending to within six inches of the upper end. The centre conductor is connected to the aerial binding post of the receiver, while the shielding is connected to the ground terminal of the receiver. This antenna will pick up radio signals only by the six inches which are unshielded and is, therefore, very useful for probing between wires. The shielding should be insulated, as contact from the shield to any metal or ground will cause noise in the radio receiver. An additional insulation, such as a fibre tube, may be placed over the upper end of the probe antenna.

It is useful to have the portable receiver thoroughly shielded when working in a power house or other place where the intensity of the radiating field is so great that an unshielded receiver would pick up stray fields.

Government Interference Cars

The photograph shows one of the cars operated by the Radio Branch, Department of Marine, for the investigation of radio interference.

There are, at the present time, twenty-four interference patrol cars operating in Canada. Each car has a loop erected permanently on the roof and the control is brought through the roof and placed so that the loop direction can be changed by the driver. A low capacity lead connects the loop with an eight tube superheterodyne receiver, which is mounted in a portable case and may be supplied either from the batteries contained in another portable cabinet or from storage batteries carried in a compartment in the car.

An additional portable superheterodyne receiver is carried in one of the storage cabinets. The two receivers are interchangeable, the second being used either as a spare or for special investigations where it is necessary for an observer to listen on a receiver at some fixed point while the car is on patrol.

The rear of this car is fitted with a step and a convenient handle for the use of a lineman when investigating interference from distribution systems.

The car carries, also, a small portable receiver, exploring coil, jointed rod, surge traps and other apparatus for the investigation and elimination of interference.

Radio Receiver

The loop of the receiver is used for determining which wires radiate the greatest interference; it is not possible, as some people imagine, to use the directional properties of this loop to point directly to the source. When investigating interference from the distribution system the car can be placed where different circuits cross each other, and, if the loop be then rotated to parallel the various circuits in turn, the maximum response in the radio receiver will indicate the

circuit radiating the greater interference.

SERIES STREET LIGHTING CIRCUIT

Faults on series street lighting circuits usually cause greater interference than similar faults on the distribution system. This interference will, also, extend a greater distance from the source and is very difficult to locate when it is intermittent. On ungrounded lighting circuits the interference will vary according to the changing conditions at the source, and, also, according to varying voltage from the line to ground at the point at which the fault occurs. On an ungrounded street light system the voltage to ground near the fault may be very low at one instant on account of leakage due to tree contacts or other causes near the fault, and considerably greater at another instant owing to increased leakage elsewhere on the system; thus, the interference from the fault will vary considerably.

In order to find the source of this interference, it is, therefore, desirable to maintain approximately constant voltage from line to ground at the fault. This may be done by open-circuiting the line and putting it on a potential of, say, 2,000 volts. If the interference becomes more continuous an investigation may be carried out in the ordinary way.

Interference is more frequently noted on series street lighting circuits where the line wires pass through conduits on the poles or through goose-neck fixtures to the lamp heads. Where the conduit or fixture is not thoroughly grounded and is insulated In the wooden pole, the system may continue to operate satisfactorily and show no grounds, although there may be defective wiring in the conduits causing severe radio interference.

It is suggested that a test be made on systems repeatedly causing interference by putting normal operating voltage on the entire system open circuited, and placing grounds on all conduits and fixtures to test the insulation of the line wires at these points, independent of the insulating value of the poles carrying the fixtures.

SOURCES OF INTERFERENCE, IN ONTARIO, INVESTIGATED, BY RADIO BRANCH

A Summary of Sources of Inductive Interference, in Ontario, investigated during the past two fiscal years, ending March 30th, 1930, is given in the following table.

The amount of interference caused by distribution systems throughout Ontario is on the decrease, due to improved maintenance by many public utilities, who are giving serious consideration to the question of radio interference from their systems. This condition is particularly noticeable in the Section of Ontario bounded by Peterborough, Goderich, Windsor and Niagara, as shown by the fact that, in this district in 1928-29, the number of defective transformer cutouts found to be causing interference amounted to 1,099, while in 1929-30 this number was reduced to 762.

Unfortunately, a number of broadcast listeners who have recently installed radio receivers of greater sensitivity hear more noise from their new sets when listening to distant stations than they were accustomed to when using their old sets, and,

	1928–29	1929–30
Domestic and Commercial Apparatus	884	930
Distribution Systems and Power Lines	2,689	3,624
Total Sources	3,573	4,554

SUMMARY OF SOURCES FOUND ON DISTRIBUTION SYSTEMS AND POWER LINES AS LISTED ABOVE

	1928–29	1929–30
Cutouts (Transformer Fuses)	2,037	2,021
Lightning Arresters	188	229
Loose Series Connections, (other than cutouts)	86	374
Line Contacts with ungrounded metal (such as guy-wires, brackets, transformer cases, etc.)	237	274
Line Contacts with grounded material (other than lightning arresters, such as trees, poles, grounded metal, etc.)	80	344
Defective Insulators and Bushings	15	59
Faults on Lines of over 8,000 volts	46	323
TOTAL	2,689	3,624

therefore, do not appreciate the improvement in reception conditions.

The lines of some public utilities are, however, still far from satisfactory, from a radio standpoint, and investigators have, in one day, located as many as forty-five faults on the distribution systems in one city, which faults were causing radio interference. This number may be compared with forty-nine faults found in six months in a larger city where the lines are maintained in good condition.

Cutouts

It is seen from the Summary that the greatest number of sources of interference on the distribution systems is due to defective cutouts and can usually be traced to the old type of porcelain cutout having open fuses. The type which plugs straight in and that which closes with a quarter turn are equally bad from the interference point of view. Very few cases of interference have been found to be caused by oil immersed fuses or the cartridge type, including the expulsion fuses. Several cases, however, have been recently brought to our attention, where interference has been caused by the expulsion type of fuse in which ordinary fuse wire has been used in place of the special fuse link. In each of these cases, the fuse wire had been cut by the terminal screw and this caused the primary current of the transformer to arc across a very small gap. This interference might continue indefinitely without sufficient heat being generated to blow the fuse.

On examination of the old type of cutout causing interference, it is

usually found that the copper jaws have lost their temper due to heating and the blades have become corroded. It is frequently noticed that the copper has fused from the blade to the jaw, thus, making a perfect metallic contact of very small area (not much more than a pin point). This probably accounts for the intermittent nature of the interference, as there will be no interference as long as this fused contact holds, but the slightest vibration caused by wind or passing traffic will break this fused pin point of copper and the arcing from the blade to the jaw will recommence, causing interference.

Lightning Arresters

Another common source of radio interference is found to be the pole type of lightning arrester. The figures given in the Summary of 188 and 229 lightning arresters include only the sources where the interference was found to originate in a defective arrester and do not include a great number of sources caused by loose connections from the arrester to the line. The type of arrester which usually causes interference is the old type of series gap arrester mounted in a wooden box, in which some of the gap electrodes have become corroded or burnt by lightning discharge. Interference from some of the new types of arresters mounted in porcelain has been found to be caused by defects due to moisture inside the arrester. Unfortunately, a number of arresters having an inferior type of porcelain cap were installed but the manufacturers of these arresters have replaced the caps of a great many, fitting them with wet process porcelain.

Loose Series Connections

Loose series connections on 110 and 220 volt grounded neutral circuits do not usually cause radio interference beyond the secondary circuit on which the fault occurs, unless it is closely coupled to other circuits.

Loose connections on 550 volt circuits cause severe interference on all lines of this secondary system and, sometimes, set up a surge on the 2,200 volt primary which will cause interference for a considerable distance. If the transformer case is grounded, the surge induced from the secondary to primary winding of the transformer will not be so severe but the interference may be widespread if the 550 volt lines carrying the interfering surge run parallel and in close proximity to the primary lines. Many severe cases of interference have been traced to faults on 550 volt systems which have been aggravated by the vibration of the motors.

Widespread interference is often caused by loose series connections on 2,200 volt primaries and the interference is usually more severe where there is very little current passing the fault. Series faults on heavily loaded lines usually produce heat so that they do not continue for long periods without causing an interruption to the service. Connections between dissimilar metals, such as from aluminum lines to copper branch circuits, will cause radio interference if not carefully made. A severe case of interference was traced to a connection from the aluminum line to a copper wire; a special connector was used having a copper bushing for connection to the copper line and an aluminum bushing for connection to

the aluminum line. These bushings had become accidentally interchanged with the result that corrosion developed between the copper and aluminum surfaces and arcing occurred across this corroded contact.

Contacts With Ungrounded Metal

Greater interference is caused by contacts with ungrounded metal, on lines of 500 volts or more, where very small charging current only sparks across the fault, than is the case where considerable power current passes the fault. This class of interference includes contacts from lines to pole line hardware, ungrounded transformer cases, loose tie-wires on insulators, ungrounded metal in street light fixtures, and foreign metal, such as wire accidentally falling over line, etc.

Many of these sources of radio interference have been found, also, to create hazardous conditions for linemen and the general public. A case of interference was recently traced along the 2,200 volt primary a distance of three-quarters of a mile from the receiver affected and it was found that an unused radio aerial was in contact with the primary; the owner of the aerial informed the investigator that a dealer had arranged to connect a set to this aerial the following day. This investigation probably prevented a serious accident.

A common fault found on series street lighting fixtures is caused by the leads from the auto-transformer to the lamp sparking to insulated metal in the lamp fixture. These leads are insulated to withstand only the low voltage of the lamp and the fault will not cause any trouble with the lighting systems on account of the fact that the metal in contact with the leads is insulated from line and ground. Although, from the power point of view, these leads are required to withstand only 50 volts, which is the voltage across the lamp, they are subjected to nearly the full voltage of the line as far as radio interference is concerned. The iron of the fixture forms an intermediate plate of a series condenser from line to ground and a spark occurs through the poor insulation of the lead, electrostatically charging the iron. This matter was brought to the attention of the manufacturers, who were pleased to alter the design of their fixtures, insulating all conductors connected to the lines to withstand the high voltage test. This type of interference would occur less frequently, if all conductors, whose operating voltage does not exceed 5,000 volts, were insulated to withstand 25 per cent. above operating voltage, this test voltage to be applied between the conductor and all ungrounded metal not properly bonded to the conductor.

Contacts With Grounded Material

Very little interference is found to continue from low resistance grounds, as such faults usually cause an interruption to the service and may be located and repaired by ordinary methods.

Interference from high resistance grounds on circuits of 500 volts, and greater, cause considerable interference. This class includes accidental contacts to trees, damp poles, etc.

Defective Insulators and Bushings

Defective insulators and bushings of pole line apparatus will cause very severe interference when a spark occurs from the conductor across the defective insulator to some metal, and the interference is usually found to be greater when this metal is ungrounded.

High Voltage Transmission Lines

Radio interference from high tension transmission lines may be caused by faults or by the normal operation of the line.

The term "faults" is used here to describe an abnormal condition of the line which causes radio interference, although a condition of this nature may not be considered a serious fault from the power point of view if it does not affect the operation of the line.

Radio interference caused by the normal operation of the line is often referred to as "normal high tension fry" and may be recognized by the fact that it is usually less when the insulators are wet, during rain or mist, than when the insulators are dry. This normal high tension fry is principally caused either by the electrostatic discharge between line and tie-wires or other metal in close proximity to the line, such as line wire clamps, etc., or by the electrostatic discharge from the line to the surface of the insulators. Reception conditions have been improved by re-tying several miles of line with a type of tie well bonded to the line. Unfortunately, however, as interference carries several miles along the line, it is sometimes necessary to retie a considerable section of the high voltage line, in order to improve reception conditions at any one point.

Faults causing radio interference occur less frequently on high voltage transmission lines than on distribution systems, on account of the higher standard of construction and maintenance usually found on such lines. When faults do occur, however, on the former, they cause much more severe radio interference and it will carry a great deal further. Faults on high voltage lines very often seriously affect radio receivers twenty miles or more along the line from the fault. The greater distance which the interference carries may be attributed both to the higher voltage at the source and, also, to the fact that there is less capacity to ground on the high voltage transmission lines than on distribution systems.

Electric Railway Systems

Interference from the electric railway systems may, also, be classified under the headings "faults" and "normal operation", but, in this case, it is much more difficult to distinguish without a thorough investigation. Interference from the normal operation of electric railway systems may be considered under the following headings :

(a) Commutation of the generators ;
(b) Apparatus in the street cars, including traction motors, compressor motors, controllers, etc.;
(c) Sparking at the trolley.

Interference from the commutators of generators is frequently associated

with conditions which cause sparking, although there may be commutator interference when practically no sparking is visible. Some generators have their brushes set in such a position as to give reasonably good commutation between, say, 25 per cent. full load and moderate overload, but, when the load drops below 25 per cent., sparking occurs at the commutator and the radio interference increases. Fortunately, however, when this occurs, it is usually at times when few people are using their receivers, such as when few cars are in operation after midnight.

Considerable interference is caused by the apparatus on the street car and, occasionally, it is possible to determine which particular piece of apparatus causes interference by the characteristic sound in the radio receiver, for instance when the pitch of the commutator interference from the traction motor rises as the motor accelerates.

Many methods of reducing interference from the apparatus on the street cars have been suggested and tried with varying degrees of success. In several cities in England the traction companies have gone to considerable expense in order to change the connections of their traction motors so as to place the series field coil on the line side of the armature as a choke to prevent surges from the commutator reaching the trolley. Tests conducted on various traction systems, in Canada, indicated that reception conditions would not be materially improved by eliminating preventable interference from apparatus in the street car, as interference from the connection between the trolley line and the car is the cause of greatest noise in the radio receivers.

Experiments are now being conducted in an endeavour to find a means of reducing interference radiating from the trolley lines, and preliminary tests indicate that it is possible to reduce the noise level materially where trolley feeders pass through residential districts away from the car line. Condensers connected from these feeders through suitable fuses to ground, and spaced a few hundred yards apart, have reduced the noise level in some districts but the most economical method of dealing with this matter has not yet been determined.

Telephone Systems

Radio interference may be caused by the operation of the impulse contacts of the subscribers' automatic telephones, where the radio aerial is placed near the telephone lines. This interference, however, does not usually carry more than a few hundred feet along the open telephone wiring and practically no radiation is observed from lead covered aerial cable.

The Bell Telephone Company have developed a suppression device consisting of a small condenser with a resistance in series, to be connected across the impulse contacts of the telephone causing the interference. This is made up in a simple unit which the Telephone Company can fit inside the frame of the standard telephone.

Many types of ringers are apt to cause radio interference but the Bell Telephone Company and most of the independent telephone companies in Ontario have installed suppression

devices on the ringing apparatus so that there is very little interference experienced from this source to-day. The pole changers, used to supply ringing current from batteries, usually require a simple choke coil consisting of 350 turns of No. 22 wire, wound on a wooden bobbin, one choke coil being installed in each ringing lead, within a few inches of the ringer terminal. The frequency converters, consisting of vibrating types of rectifiers in combination with the pole changers, frequently require similar choke coils in both the power supply and the ringing circuits. The rotary composite type of ringer sometimes requires condensers across the motor input, and, generally, requires choke coils in the pulsating circuits near the output terminals of the ringer.

Battery chargers and other electrical apparatus in the telephone exchange may require interference suppression devices as described elsewhere.

Telegraph Systems

Wherever an inductive circuit in the telegraph system is broken, there is apt to be a certain amount of radio interference.

Oscillograph records of the voltage from line to ground on a telegraph circuit supplied from a 50 volt battery sometimes indicate a surge of very steep wavefront amounting to between 200 and 300 volts. This surge is of one polarity when the circuit is broken and the opposite polarity, although not so intense, when the circuit is closed. The surge usually consists of a very steep wavefront, the voltage returning to normal in a few micro-seconds, and very seldom continues to oscillate for more than one or one and one-half cycles. This surge may travel along the telegraph line causing severe radio interference to receivers near the line, at a distance of four or five miles from the source.

Due to the fact that the surge on breaking the circuit is more severe than the surge on making, clicks in the radio receiver are often heard only when the key is raised, with the result that a telegraph operator can seldom read the telegraph signals when listening to the interference on a radio receiver. This adds to the difficulty of the investigator in his endeavour to determine which line or apparatus is causing the interference. In order, therefore, to carry out an investigation, it is necessary to listen in on a radio receiver while certain prearranged signals are transmitted by the various instruments in the telegraph office, at a time when interference from telegraph traffic will not interfere with the observations.

Although the interference from breaking main line circuits is more severe, considerable interference may be caused by the breaking of the local battery sounder circuit, particularly if the wires of the local circuit run parallel to main line wires in the telegraph office or any a. c. circuits.

The telegraph companies install standard suppression devices, which they have developed in co-operation with the Radio Branch, on keys and relays found to cause radio interference. These suppression devices consist of a condenser with a resistance in series connected across the telegraph key or relay contacts, and a combination of choke coils in the telegraph lines and condensers across

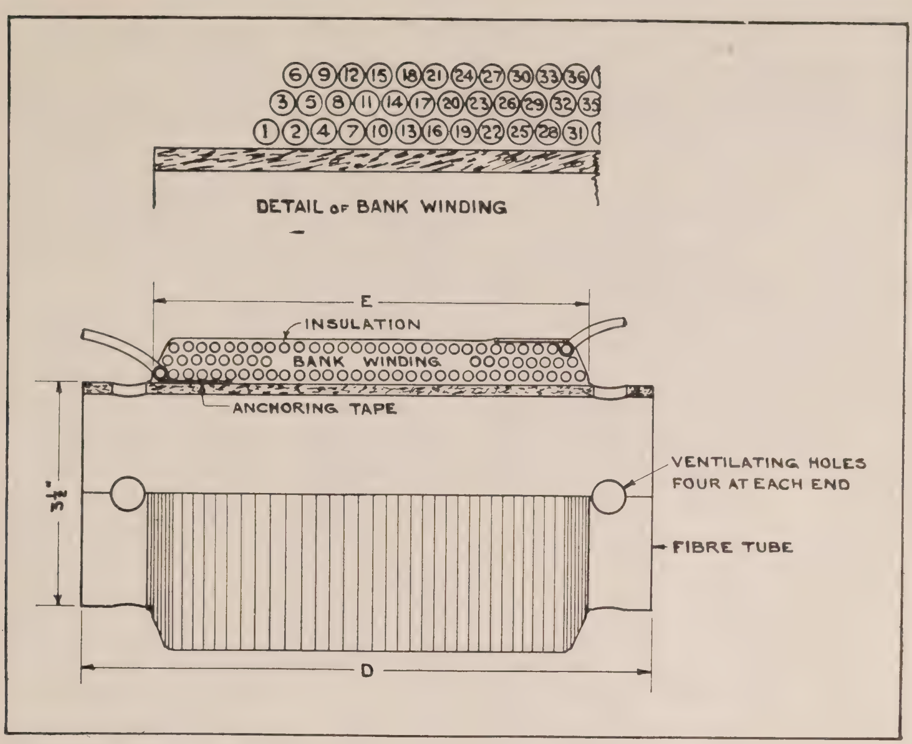


Figure 3.—Choke Coil showing Details of Construction.

BANK WOUND CHOKE COILS

Type 100 turns	Amps.	Wire B. & S.	Dimensions: Size of Box A	B	C	Coil D	E	Type 150 turns	Length D
B.M. 14	6	14	6	12	6	5-7/8	4½	B.M. 14-S	7-7/8
B.M. 12	8	12	8	12	6	7-7/8	5	B.M. 12-S	9-7/8
B.M. 10	12	10	8	12	6	7-7/8	6	B.M. 10-S	9-7/8
B.M. 8	18	8	10	12	6	9-7/8	7	B.M. 8-S	11-7/8
B.M. 6	24	6	10	12	6	9-7/8	8½	B.M. 6-S	13-7/8
B.M. 4	32	4	14	14	6	13-7/8	11½	B.M. 4-S	19-7/8

the key. The condensers are sometimes referred to as spark killers and the choke coils or combinations of choke coils and condensers are referred to as suppressors.

Surge Traps

In order to prevent interference from the normal operation of electrical apparatus, surge traps are installed in the leads near the terminals to reduce the surge, or prevent it from reaching the lines. These surge traps consist of condensers, choke coils, resistances, and combinations of these units.

The purpose of the condenser is to reduce the voltage of the surge by providing a by-pass of low impedance for the surge, which will not conduct the power current. It is often found that the installation of condensers improves the operation of the electrical apparatus by reducing the sparking. The capacity of the condensers for this purpose is not critical and the following sizes are suitable for most cases : 1/10, 1/2, 1 and 2 mf. Condensers should be made to withstand a test voltage of several times line voltage, as the surge which causes radio interference has, very often, instantaneous values greatly in excess of the line voltage.

Choke coils which will carry the power current without any material loss are placed in the line to introduce a high impedance to the interfering surge. The inductance of the choke coils varies from 1/4 to 15 millihenries, depending on the characteristics of the interfering surge. Choke coils for this purpose must be designed so as to have very low distributed capacity. The distributed capacity of a choke coil is the property equivalent to a condenser connected in parallel with an ideal choke coil having no distributed capacity. This distributed capacity forms a by-pass, which will conduct the surge to the line, from which it will radiate and cause interference.

The ideal choke coil is made by winding insulated wire, in a single layer, on a cylinder of fibre or other insulating material. As this type of construction, however, takes up considerable space, the choke coils may be wound according to the method known as bank winding, shown in the illustration. Ordinary multiple layer winding is practically useless for the construction of choke coils, as the distributed capacity between adjacent layers is excessive. Choke coils should not be impregnated with wax or other dielectric, as the dielectric constant of these substances is greater than air and, thus, increases the distributed capacity.

Figure 3 and accompanying table give a list of choke coils suitable for the suppression of interference for various loads. Type B. M. coils having one hundred turns are usually sufficient, but tests sometimes indicate that it is necessary to use the B. M–S coils which have one hundred and fifty turns.

The accompanying figure shows types of surge traps most frequently used for the prevention of interference from the normal operation of electrical apparatus, and the table gives the types of surge traps and sizes of condensers recommended for the elimination of interference from some of the more usual types.

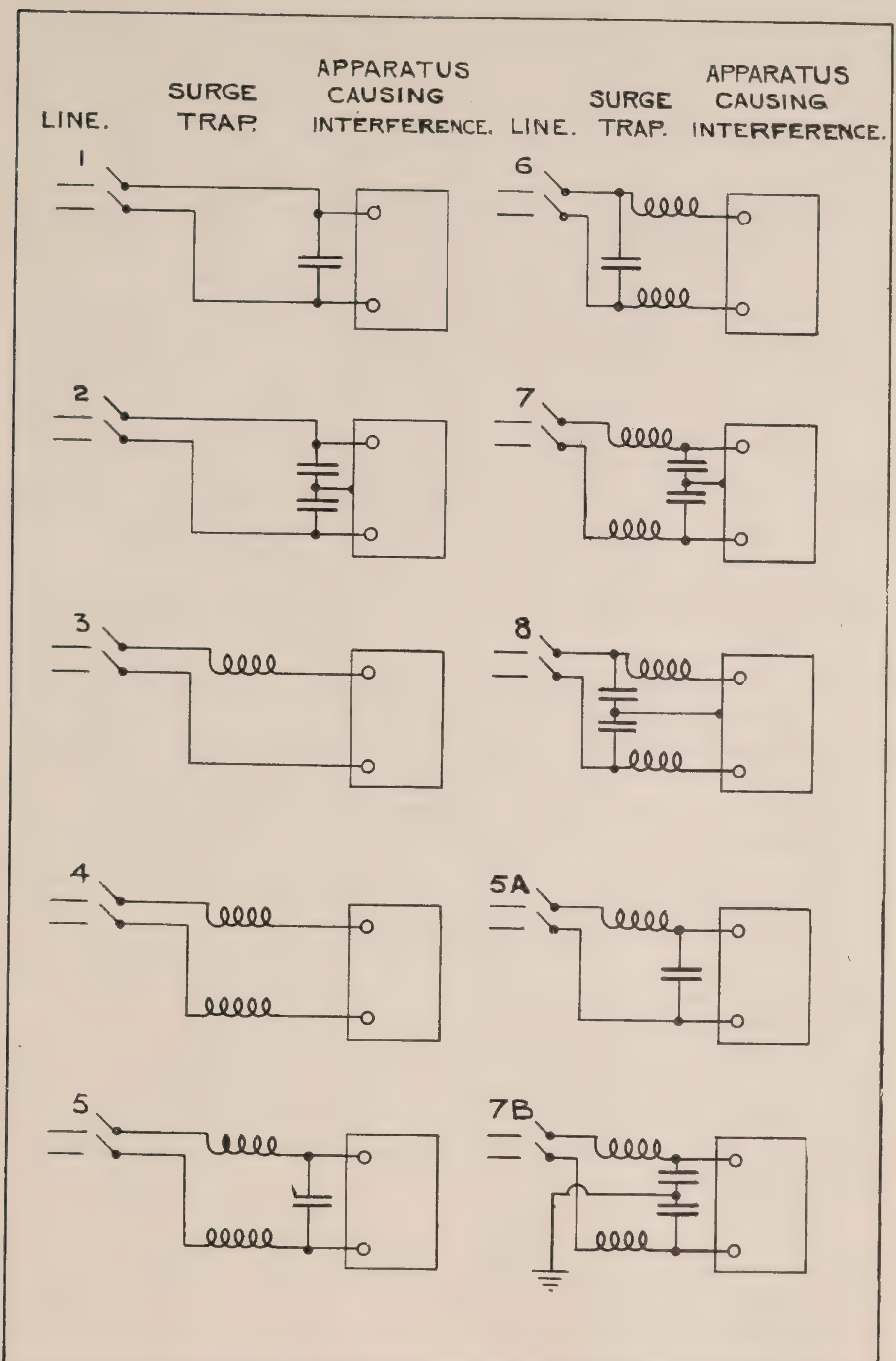


Fig 4.—Diagram of Surge Traps, Standard Types.

METHODS OF ELIMINATING RADIO INTERFERENCE FROM ELECTRICAL APPARATUS

CAUSE OF INTERFERENCE AND WHERE USED	USUAL METHOD SURGE TRAP AND SIZE CONDENSERS	ALT. METHOD SURGE TRAP AND SIZE CONDENSERS	REMARKS
(1) THERMOSTATIC CONTACTS: Heating Pads, Incubators, Small flashing signs ;	No. 1, 1/10 mf.	Cond. connected in parallel with contact breaking points, 1/10 mf.	Occasionally condensers up to 3 mf. are required;
(2) MOTOR COMMUTATOR : Barbers' clippers, Dental Lathes, Vacuum Cleaners, Sewing Machines, Blower Motors, etc.	No. 2, 1/2 mf.	No. 4.	Occasionally surge traps Nos. 7 or 8 ; larger motors require 2 mf. condensers;
(3) MECHANICAL RECTIFIERS, (VIBRATOR TYPE), Battery Chargers for "A" Batteries,	Condenser across contact breaking points–1/2 mf.	No. 1, 1 m.f.	
(4) MECHANICAL RECTIFIERS, (VIBRATOR TYPE), Battery Chargers for "B" Batteries,	No. 7, 1/2 mf.	No. 8, 1/2 mf.	
(5) MECHANICAL FLASHERS, Flashing Signs,	No. 2, 1 mf.	No. 4,	Occasionally surge traps Nos. 7 or 8 ;
(6) CIRCUIT BREAKERS, Signal Systems, Railroad crossing bells, etc.	No. 2, 1/10 mf.	Cond. across contact breaking points, 1/10 mf.	Occasionally condensers up to 2 mf. are required;

METHODS OF ELIMINATING RADIO INTERFERENCE FROM ELECTRICAL APPARATUS—CONT'D.

(7) IGNITION SYSTEMS, Internal Combustion Engines, Farm Lighting Plants etc.	No. 2, 1/10 mf.	No. 7, 1/10 mf.	Occasionally 2 mf. condensers are found necessary;
(8) KEYS AND RELAYS, Telegraph,	No. 1, 1/10 mf.	Special surge trap,	
(9) POLE CHANGER, Telephone Ringers,	No. 4,—	Special surge trap,	
(10) TUBE RECTIFIERS, Battery Chargers,	No. 2, 1/2 mf.	No. 1, 1/2 mf.	Surge Traps Nos. 7 or 8 occasionally required.

Discussion

Mr. F. K. Dalton, H.E.P.C. of Ont.—This paper and demonstration have been very interesting to me, partly because of the nature of the work but also because I have co-operated with Mr. Merriman on many occasions in endeavouring to find this elusive thing called radio interference.

It has been said, and quite truly, that if you can measure a quantity you can deal with it much better than if you have to judge by ear, or by sight. There are methods developed for the measurement of interference. In fact, we can show interference not only on an ammeter, or voltmeter, but on the oscillograph, and we can show its nature, and its phase relation to the voltage on a power line. When you measure quantities you can compare quantities, and that is a more definite way of carrying on investigations. The measurement by means of an ammeter, or an oscillograph, is certainly a desirable method for tracing interference, and I would be glad to know what Mr. Merriman's latest developments are along this line.

Mr. Merriman mentioned cutouts. I think that lightning arresters should be included with cutouts and I should like to know what the experience has been in regard to these devices, as to their condition. It is my opinion that the size of cutout or arrester does not matter so much—that is, whether it is for a small transformer or a large transformer—as its actual condition. We had a case of lightning arresters where the box covering them was somewhat old and developed cracks in the wood such that snow and

rain entered. We made a test of the arrester, and when we poured in a little water, as may come from snow or rain, immediately there was interference.

Mr. Merriman mentioned that we now have a circuit set up for checking insulators as to interference. There is considerable information obtainable with the oscillograph that is of general interest, and also of individual interest. If any municipalities are having trouble with interference, I think we would like, at least, to discuss the matter.

There is one point which is somewhat aside from the actual seeking of interference sources, but which should be of importance to municipal engineers and managers. The Institute of Radio Engineers, at various conventions, and in many sessions, has discussed this matter of radio interference. It is serious and certainly annoying, and it has occupied its due proportion of time in conferences and conventions.

At the convention in Washington about a year ago, the matter was given a special session, and it seemed to be the opinion of the engineers—which includes all the radio engineers of the continent—that a lot of the annoyance could be avoided by the salesman who sells the receiving set. There seems to be a great tendency to over-advertise the capabilities of a set as to reliable distance range under local conditions, and if one which is too sensitive for a certain locality be advertised in that locality and bought and installed there, quite frequently—one might almost say invariably—it results in some dissatisfaction.

At that convention of the I.R.E. there was discussed also this viewpoint: That in cities and towns there are certain levels of interference that can not be reduced, such as that coming from elevators and street cars and some of the various other public necessities, and that in those cities, it was absolutely unreasonable to advocate the purchase of a highly sensitive set. The question was brought up then whether manufacturers should build two sets—two different classes of sets, one for the city man and one for the country.

Of course the question was discussed by the manufacturers as well; they would prefer to sell the more sensitive set if they could. Viewing it from the angle of interference, however, I think it would always be well for local managers, if they have reports of interference, to consider the matter of sensitivity of the receiver and the possibility of local interference that cannot be reduced.

Attention has been drawn to several cases where radio sets have been installed near power lines and interference was experienced. However, a power line that is carrying a load has two features which are absolutely inherent in the circuit. While it carries a current there is a magnetic field, and while it has a potential there is an electrostatic field.

Now a number of manufacturers have built receivers in which the first thing that the aerial meets after it enters the cabinet is a small condenser. The condenser insulates the aerial from ground. In that case, even a small alternating electrostatic field may cause a very loud tapping in the loud speaker. All that may be

necessary then where the aerial is so close as to pick up the electrostatic or magnetic field, is a small drain coil connected between the aerial and ground. Several cases of interference have been successfully cured in this way. I just mention that matter, and I think probably Mr. Merriman would like to comment on it.

Mr. W. R. Catton, Brantford: I don't think there is any doubt that the utility causes a lot of interference.

We test transformer loads on the 2,200 volt side, and to do this we bridge the cutout and open the plug supplying the transformer. In the past month we found eleven cases where, if we put the plug back in the cutout and took off the clips bridging that cutout, the cutout arced, showing a possible cause of radio interference. We are taking immediate steps to replace them.

Mr. J. H. Brace, Bell Telephone Co.: I just wanted to bring one thought to this group with respect to the question of our working along with the radio people. In an experience of some years of attempting to co-ordinate the communication services and the power services, we used to speak of power interference or inductive interference, and, speaking frankly, we did not get very far in our attempts to co-ordinate the two systems. It was not until some time later when we realised that we had to work together that we changed the phrase from "inductive interference" to "inductive co-ordination." It was a problem that both had to work on and try to remedy.

Our discussion up to date in connection with radio has always dealt with "radio interference." I am just suggesting that possibly we might be well advised to change the discussion from one of "radio interference" to one of "radio co-ordination." By so doing possibly we would get our ideas on a different plane; possibly we will realise that we can work more closely with the large radio manufacturers and can overcome many of the problems by mutual assistance and supplying a means within the radio sets as well as on the power and communication systems to overcome a great many difficulties. It seems to me that it is worth while considering this as a radio co-ordination subject rather than one of radio interference.

Mr. E. V. Buchanan, London: I think the point brought up about saving expense to the utility by finding the interference before it results in serious damage, is well worth while, and this co-ordination should be carried to the fullest extent.

In October last, complaints of radio interference were coming in to us through the local interference office, from more or less all over the city. These complaints had been received during the summer—finally building up to a maximum in October, presumably as the result of putting up a large number of 600 c.p. span lights at intersections in South, West and North London the previous spring. Finally it was decided to replace all the 600 c.p. lamps with 400 c.p., after which radio conditions returned to normal. A number of lamps were returned to the H.E.P.C. and replacements are now being received with the top connection brazed instead of soldered. These are now

being put up and the 400 c.p. at intersections taken down. These lamps were enclosed in dust-proof fixtures. Our theory is that the high temperature reached within the fixture melted the solder and set up an arc. Since only brazed top connections are being used the interference seems to have been eliminated.

A Delegate: I should like to ask Mr. Brace what has been done in respect to interference from the automatic telephone.

Mr. Brace: I think that has been very well covered in Mr. Merriman's paper. We have developed a trap which will successfully overcome the difficulty. Unfortunately when these difficulties occur it involves some considerable study of the situation surrounding the particular instrument. It may be that the trouble is coming in from any one of from four to ten telephones in the vicinity. That makes it necessary to arrange with the subscribers to make trials, and then, when interference is occurring, to put on these traps.

The question of whether we would be justified in supplying such traps on all new insturments manufactured, or on existing instruments, is under very definite consideration. We are in the service of the community just as the power people are, and just as our friends in London are. We are trying to live within our means and serve the people at cost, and if we have to supply more apparatus, the cost will have to go up, so we have to consider very carefully before determining any definite policy.

So far as any one who is finding trouble is concerned, I may say that we have a very definite means of correcting it. Sometimes we find that the difficulty can be overcome by suggesting to our subscriber that he move his radio. We frequently find that he places it on the table that was formerly occupied by the telephone, and puts the telephone on top of it. The interference can be remedied when it is drawn to our attention.

Mr. H. Denef, Hanover: I would like to take exception to Mr. Merriman's reference to unsatisfactory condition of lines in outlying districts, within which classification I presume we come. We have just as much pride as the bigger centres, and I think that we and many of the other outlying districts are just as up to date as the big centres and keep our system in just as good shape as they do.

Mr. Merriman: In reply to Mr. Dalton's enquiry as to means of measuring radio interference, we usually use an output voltmeter in parallel with the loud speaker of a radio receiver, and compare the meter reading due to interference with a corresponding reading due to broadcast reception of some station within 100 miles.

I understand that the General Electric is developing an instrument known as the "Radio Noise Meter" for the purpose of locating the source of radio noise and measuring its intensity. This instrument consists of two parts, a receiver unit to detect and indicate the radio noise, and a calibrating unit to measure the intensity of the noise in microvolts per metre.

We have been using a cathode ray oscillograph with good results in the study of interfering surges from

street railway and telegraph systems. The 300 volt tube, which we are now using, is not suitable for studying the surges from high voltage lines, but we hope to conduct research as soon as facilities are available. The oscillograph, capable of recording frequencies up to 7,000 to 8,000 cycles per second, connected to the output of a radio receiver, as used by Mr. Dalton, will probably produce very valuable oscillograms.

I believe Mr. Brace's suggestion, to consider this work as radio co-ordination rather than radio interference, a decided step forward, and I feel that the service rendered to the public will be more satisfactory when considered from this point of view.

Referring to the summary of sources of interference in Ontario and Mr. Denef's remarks, I may say that, although our records show that the total number of faults found on distribution systems in Northern Ontario is high, our investigators report that some of the northern distribution systems are so maintained as to give practically no interference, and that barbers' clippers, small motors and such devices are the principal sources of trouble.

* * * *

CANADA
DEPARTMENT OF MARINE
OFFICE OF THE RADIO INSPECTOR

Toronto, Ont., February 13, 1931.

Sir:—

I am in receipt of your letter of February 11th in connection with radio interference caused by a Universal motor on barbers' clippers.

We usually find in a case of this kind, where the motor is ungrounded, that it is a comparatively simple matter to eliminate the interference by the installation of 2 1-10th mfd. condensers connected in series across the line to the motor and as close to it as possible, the centre point of the series connection being grounded to the frame of the motor. In some few isolated cases it was necessary, in addition, to insert 100 turn choke coils in each of the supply leads, but this is very rarely required.

One difficulty with barbers' clippers seems to be that it is sometimes inconvenient to install the condensers close to the motor and they are installed probably two or three feet away. This only results in the leads to the condensers acting as radiating sources for the interference and, of course, they have very tangible impedances at radio frequencies, making it very difficult to eliminate the disturbance.

The smaller capacity condenser we usually find to be much more effective, probably because this type of paper condenser is usually wound inductively and the higher capacity apparently offers higher impedance to the higher frequency surges.

If there is any way we cán co-operate with you in this particular case, we shall be only too glad to do so and, if you desire it, shall make arrangements to have one of our permanent inspectors go and assist in the conducting of experiments.

Yours faithfully,
(Sgd.) S. J. ELLIS,
Dvnl. Radio Inspector.

The Hydro-Electric Power Comm. of Ontario,
190 University Avenue,
Toronto, Ontario.

Notes on Heavy Plate Construction

By W. D. Walcot, Testing Engineer, H.E.P.C. of Ontario

WITHIN the last few years there has been a marked increase in the construction of large power projects, big developments have taken place in pulp and paper machinery, steam installations are designed with higher pressures, and similar advances have been made in other branches of mechanical and civil engineering. These have all resulted in heavier plate construction than that used in the past.

These advances and develpoments have brought in their train certain difficulties in securing workmanship of a suitable standard, and the solution of these difficulties has been brought about by changes in design and corresponding advances in shop methods.

Structures such as penstocks, digesters, boilers with high working pressures, spiral casings for turbines, and steam accumulators, are examples of the work we have in mind.

Methods of executing shop work, which are efficient in light plate work, are found to be unsatisfactory in certain respects in dealing with the heavier sections; among these are rolling, flanging, fitting and riveting.

DESIGN

Among the more important considerations in design is the pitch of the rivets. In joints where water or steam-tightness is essential the pitch should be such that caulking can be done effectively. In circumferential joints, the pitch is kept constant and the abutting steel plates are welded on the inside. It is usual to bevel plane the edge of the plates so as to provide a fillet suitable for welding.

In longitudinal joints, in order to develop the maximum efficiency, six and as many as eight lines of rivets are often necessary. It is usual to put the narrow butt strap on the outside, and the wider one carrying the long pitch on the inside. Experience has shown that six, or at the outside eight times the thickness of the plate is the maximum pitch that can be caulked efficiently. As it is the practice to make structures of this type tight from the inside, welding is sometimes done on the edges of the inner plates. Any leaks that develop are then caulked on the outside.

Bevel Planing.

There is considerable difference of opinion as to the necessity for bevel planing the edge of heavy plate with a view to caulking. It has been our experience that on heavy sections, the rolled edge as it comes from the mill can be efficiently caulked without bevel planing, but where the edges have been sheared and are uneven, planing is necessary.

Sub-Punching and Reaming

All holes on work of this description should be sub-punched at least one quarter of an inch smaller than the diameter of the finished hole, and then reamed to size after assembly.

On elbows or other curved sections sub-punching should be at least three-eighths of an inch smaller than the finished hole in order to

Fig. 1—Digester in Course of Erection

take care of inaccuracies introduced by uneven flanging, drilling and punching.

Shop Work

Among the more important considerations under this heading are: (A) Cutting with either shear or torch; (B) Flanging; (C) Fitting; (D) Riveting.

Sections of a thickness of about one and one-half inches or more cannot readily be sheared, and cutting with the acetylene torch is the usual practice. This leaves an irregular edge of damaged metal of a thickness of about three thirty-seconds of an inch, which should be removed. The danger is that cracks are sometimes started in the edge of the plate, and this condition is aggravated by rolling. At least one-eighth of an inch, and preferably three-sixteenths of an inch, should be chipped or planed from the edge of heavy plate cut in this manner.

Flanging

In order to get a good fit between the plates, it is necessary to resort to flanging on elbows and other curved surfaces. The bevels for each quadrant are calculated and each abutting plate is flanged for a distance equal to half the width of the circumferential butt strap. On the accuracy of the flanging depends the closeness of contact of the plates and the matching of the holes. While this operation is not a difficult one, it must be done carefully and conscientiously in order to obtain the best results. On turbine scroll cases and similar structures where there is a continuity of the curved surface with varying radii, local heating is often employed in order to correct inaccuracies in rolling and flanging. This procedure involves two difficulties. First, there is the danger of overheating; and secondly, there is a tendency to leave unrelieved strains in the material. This method should only be adopted where other methods cannot be used.

Fitting

Amongst the most important considerations under the heading of "Fitting" is that of keeping the plates in complete contact. Any obstructions which would tend to keep the surfaces from the closest contact should be avoided. Burrs caused from punching or drilling should be removed by means of a sharp cutting tool, or by countersinking the hole lightly. Contact surface should not be painted, but

should be scraped or brushed with a stiff wire brush. After rivetting, the joints on the outside should be sealed with a good thick layer of red lead or other suitable primer. The use of feelers is recommended in work of this class for determining how closely the plates have been brought into contact with each other.

Riveting

The most important factors in obtaining good riveting are fair holes, proper bolting, and sufficient air pressure for the riveting machines. The methods of obtaining good holes by sub-punching and reaming have already been discussed.

In bolting, the plates should be pressed together by a power machine and brought into contact by the use of flat dies. Bolts should then be tightened with a suitable wrench with a long lever arm operated by at least two men. Care should be taken not to strip the threads in carrying out this operation.

On work of this description, and particularly where flanging has been done, bolts should be placed in every other hole at least.

Compressors used for supplying the riveting machines should be of large enough capacity to maintain a pressure of at least one hundred pounds per square inch continuously. A pressure gauge should be installed in the shop so that the pressure can always be observed.

Hydraulic riveting machines give the best results. Choke neck rivets are a help in obtaining tightness, particularly in the field. Quenching the dies with cold water after driving is advisable as it prevents the dies from overheating and reduces the time that the rivet must be held after driving.

In the case of rivets of large diameter and very long grip, quenching the end slightly in water before driving causes the shank of the rivet to fill the hole before the formation of the other head.

In testing rivets over one inch in diameter, not only should the rivets be tapped, but a test should

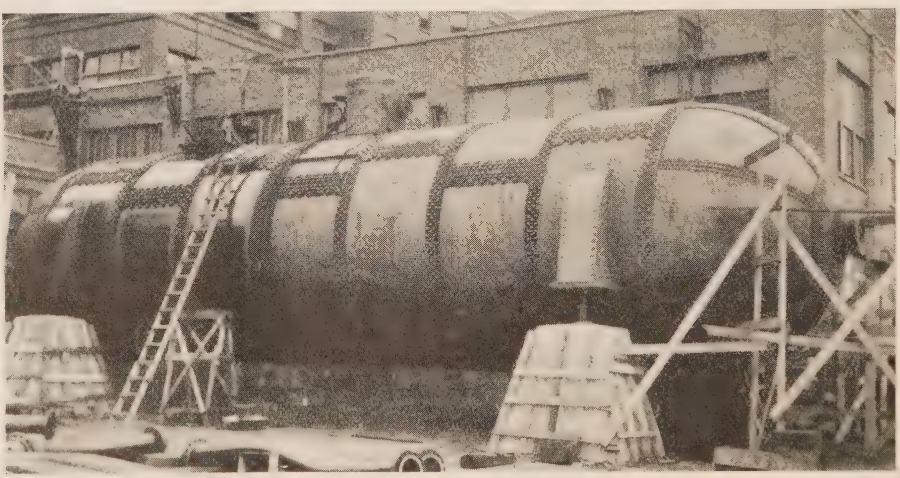


Fig. 2—Ruth Steam Accumulator

Fig. 3—Assembly of Elbow for No. 10 Penstock, Queenston

be made to see that the riveting machine is powerful enough to force the rivet to fill the hole as completely as possible. This can be done by chipping one head off and observing the degree of difficulty with which the rivet can be backed out or removed. It is quite possible to drive a rivet of large diameter which will not jar when tapped, and yet does not fill the hole completely.

ERECTION

It has been found advisable when erecting structures of circular cross section to put in timbers for bracing before shipment in the method shown in the accompanying photograph (Fig. 3).

These timbers help to keep the structure in shape and will save a considerable amount of pinning during erection.

Methods of bolting and riveting have been already taken up earlier in the article. The heads of rivets, which are not driven by power machines, should be carefully caulked.

The photographs accompanying the article show some of the types of structures referred to, and illustrate some of the phases of fabrication.

Association of Municipal Electrical Utilities

Minutes of Convention

The twenty-eighth Convention of the Association of Municipal Electrical Utilities was opened at the Royal York Hotel, Toronto, on Thursday, January 8th, 1931. The first session of the Convention was called to order by the President, Mr. R. L. Dobbin, at 10.30 a.m.

The Secretary read the Auditors' Report for the year 1930. This showed the Association to have had $1,664.89 cash in the bank at the end of 1929. At the end of 1930 there was a bank balance of $1,041.58, after having invested $1,046.20 in a bond. On motion of Mr. J. E. B. Phelps, seconded by Mr. J. G. Archibald the Auditors' Report was adopted.

The Secretary reported the following desiring to become Associates: Messrs. W. B. Munro, H. T. Macdonald, W. A. H. Nesbitt, F. A. Archer, W. B. Buchanan, F. K

D'Alton, W. C. Cale, A. S. L. Barnes, and G. G. Cousins, H.E.P.C. of Ontario, and P. T. Gaston, Electrical Inspection Department. He also reported that Jas. R. Kerney Corporation, Limited, Toronto, and Irving Smith and Company, Montreal and Toronto, desired Commercial membership.

It was moved by Mr. H. F. Shearer and seconded by Mr. J. W. Peart

"THAT the names presented by the Secretary for Associates and Commercial membership be accepted."—*Carried.*

Mr. O. H. Scott, Chairman, Merchandising Committee, presented a report from that Committee and moved its adoption, which was seconded by Mr. H. F. Shearer. Discussion on the report was by Messrs. W. E. Swartz, W. R. Catton, H. F. Shearer, E. M. Ashworth and E. V. Buchanan. The report was then adopted.

Mr. C. T. Barnes, Chairman, Committee on Accident Prevention and Health Promotion, read a report from that Committee and moved its adoption, which was seconded by Mr. O. H. Scott. Discussion on the report was by Messrs. O. H. Scott and Wills Maclachlan, after which the report was adopted.

Mr. R. J. Smith, Chairman, Regulations and Standards Committee, reported progress in that Committee but did not present a report.

Mr. J. E. B. Phelps, Chairman, Rates Committee advised that he had no report for presentation.

It was moved by Mr. T. W. Brackinreid and seconded by Mr. A. M. Bowman, "THAT the by-laws be amended by the insertion in Clause 7, Standing Committees, Paragraph (a) :—

8. Committee on Accounting and Office Administration."—*Carried.*

The session adjourned at 11.30 a.m.

At 12.30 p.m. the Association met with the Ontario Municipal Electrical Association for the first Convention Luncheon. Mr. M. B. Tudhope, K.C., Orillia, was guest and gave an address entitled "Let us go Fishing" which was both amusing and instructive. A vote of thanks to the speaker was moved by Mr. E. I. Sifton and seconded by Mr. W. W. Pope.

The second session of the Convention opened at 2.30 p.m., when Mr. John C. Emo, Industrial Acceptance Corporation, Toronto, read a paper "Time Payment Sales". Discussion on this paper was by Messrs. H. T. Macdonald, H. F. Shearer and A. W. J. Stewart.

Mr. M. J. Bell, President, Bell Lumber and Pole Company, Minneapolis, Minn., read a paper "Wood Poles, with Special Reference to Western Cedar and its Qualities for use by the Electric Utilities." Discussion following this paper was by Messrs. J. Gibbons, A. G. Lang, W. R. Catton, S. Ellerker, A. E. Davison, R. H. Starr, Wills Maclachlan and T. F. Howlett.

The scrutineers reported the results of the elections for officers for the year 1931 as follows :—

PRESIDENT—J. W. Peart, St. Thomas, Ont.

VICE-PRESIDENT—C. E. Schwenger, Toronto.

SECRETARY—S. R. A. Clement, H.E.P.C., of Ontario, Toronto.

TREASURER—H. T. Macdonald, H.E.P.C., of Ontario, Toronto.

Directors—(from the membership at large)—E. V. Buchanan, London; J. E. B. Phelps, Sarnia, and O. H. Scott, Belleville.

District Directors

Niagara District:—R. S. Reynolds, Chatham, Ont.

Central District:—G. E. Chase, Bowmanville, and C. A. Walters, Napanee, tie. (At the meeting of the Executive Committee held on that evening, Mr. Chase and Mr. Walters asked that the election be decided by tossing a coin. This was done and Mr. Walters was declared elected.)

Georgian Bay District:—E. J. Stapleton, Collingwood, Ont.

Eastern District:— H. S. Brown, Brockville, Ont.

Northern District:—T. W. Brackinreid, Port Arthur.

The session then adjourned.

The third session of the Convention opened at 9.30 a.m., on Friday, January 9th. Mr. A. G. Evans, Assistant to Chief Inspector, Toronto Hydro-Electric System, read a paper entitled "Making Friends of the Public". Discussion on this paper was by Messrs. R. H. Starr, E. V. Buchanan, G. G. Cousins, H. F. Shearer, C. E. Kirkby and J. E. B. Phelps.

Next item was a paper "Public Utilities Reduce Radio Interference" by Mr. H. O. Merriman, Engineer in Charge, Interference Section, Radio Branch, Dept. of Marine, Ottawa, which he illustrated by lantern slides and demonstrations of interference. Discussion following Mr. Merriman's paper was by Messrs. F. K. D'Alton, W. R. Catton, J. H. Brace, E. V. Buchanan and H. Denef.

The session then adjourned.

At 12.30 p.m. the Association met with the Ontario Municipal Electrical Association for the second Convention luncheon. The guest speaker was Mr. C. A. Magrath, Chairman, Hydro-Electric Power Commission of Ontario. At the conclusion of his very able address, a vote of thanks to the speaker was moved by Col. F. C. McCordick, Mayor, St. Catherines and seconded by Mayor C. M. Bezeau of Kitchener and carried with hearty applause.

The fourth session of the Convention was called to order at 2.30 p.m., when Mr. A. W. Murdock, Assistant Engineer, Municipal Engineering Department, H.E.P.C. of Ontario, presented a paper "A Few Operating Characteristics of Domestic Motors, Radio Sets and Neon Signs". Discussion following Mr. Murdock's paper was by Messrs. W. H. Mulligan, T. C. James, G. G. Cousins, C. E. Schwenger and J. J. Jeffery.

The remaining portion of this session was devoted to the "Convention Question Box" when questions concerning the operation of the systems that had been sent in previously and then circulated among the members were answered.

The Convention then closed.

Concurrent with the Convention sessions on the afternoon of January 8th and morning of January 9th, there was a round table conference on Accounting and Office Administration.

Mr. A. B. Manson, Stratford, acted as Chairman of the conference.

The first subject discussed was Consumers' Deposits and Collection of Arrears. Those entering into the discussion were, Messrs. J. W. Peart, H. F. Shearer, A. B. Scott, I. N. Pritchard, J. C. Johnston, L. E. L. Davey, R. M. Bond, T. W. Duggan, Miss Mary Grant, D. J. McAuley, W. E. Swartz, W. G. Hanna, H. J. MacTavish, W. E. Wallace, D. B. McColl, H. T. Macdonald, A. C. Herrington, C. A. Walters and P. B. Yates.

It was moved by Mr. P. B. Yates, and seconded by D. J. McAuley,—

"THAT those interested in the subject of Consumers' Deposits and the Collection of Arrears send in to the Committee on Accounting and Office Administration just before the next Winter Convention, their experience during the year, showing the percentage of losses in uncollectible accounts in relation to the entire domestic revenue, and a brief summary as to what is done to keep down those losses."—*Carried.*

Next was the question of co-operation between municipalities in collecting accounts that have been incurred by moving out. This was discussed by Messrs. P. B. Yates, D. B. McColl, H. F. Shearer, B. Thackeray, W. E. Swartz, W. G. Hanna, O. Ellwood and A. B. Scott.

Mr. W. N. Street, insurance representative of the Insurance and Pension Scheme, gave a short address inviting the delegates to visit his office for the purpose of inspecting the manner in which this was being taken care of. This completed the proceedings of the afternoon of January 8th.

At the opening of the session on the morning of January 9th, various phases of the Standard Interpretations of Rates were discussed. Those entering into this discussion were Messrs. B. Thackeray, O. Ellwood, R. M. Bond, V. B. Coleman, A. M. Bowman, J. H. Caster, J. J. Jeffery, J. C. Johnston, A. W. J. St. John, R. P. Darrell, D. B. McColl, A. C. Herrington, W. E. Reesor, F. Barber, C. E. Brown and W. G. Hanna.

The session then adjourned.

On the evening of January 9th at 7.00 o'clock, the Association met with the Ontario Municipal Electrical Association for the Convention dinner. Mr. C. A. Maguire, President, O. M. E. A., was toastmaster and Honourable G. Howard Ferguson, Canadian High Commissioner to Great Britain, was the guest speaker. After a musical entertainment furnished by Will J. White, there was a short address by Honourable George Henry, Premier of Ontario. On behalf of the O.M.E.A., Mr. August Lang presented Honourable Mr. Ferguson with an illuminated address and a painting, and Miss Mary Grant presented Mrs. Ferguson with a large bouquet.

The register shows the total attendance at the Convention to have been 440, classified as follows :

Class "A"	101
Class "B"	144
Associates	54
Commercial Members	99
Visitors	42

There were 355 present at the Convention luncheon on January 8th and 441 at the luncheon of January 9th. At the Convention dinner on the evening of January 9th there were 469 present.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

The Pruning of Trees along Transmission Lines

By W. Ray Hunter, in charge of Forestry Section, Operating Dept., H.E.P.C. of Ont.

THE problem of pruning trees along Hydro transmission lines to maintain adequate clearance for the wires has presented many difficulties to the Commission, and the yearly extensions of our lines into new territory add thousands of trees which must be given initial pruning for the new construction and followed up at regular intervals to keep the trees under control. The mistakes of improper pruning in the past must be rectified in the countless number of trees on our present system, together with symmetrical shaping so far as practical and periodical repruning as conditions demand.

The horticultural societies, civic bodies and property owners plant thousands of trees along the highways which must be pruned and shaped to prevent interference in later years. The Commission is vitally interested in maintaining the best possible appearance of these trees as it contributes materially to the beauty of the landscape along our highways and is a real benefit in building public goodwill.

Early in the year 1929, the subject of scientific tree pruning by men specially trained in this work was presented to the Operating Department officials. It gave a splendid opportunity to experiment and see what could be accomplished by men who have a thorough knowledge of the life of trees. The group employed to carry on this trial was given instructions to proceed on a line extending approximately twelve miles along an important Provincial Highway. They were to correct the damage done by the untrained employees, and, in addition, prune the trees of all interfering branches, removing all hazards and possibility of interruption from this source. The original authorization involved approximately a thousand trees; a distinct improvement was made notwithstanding the fact that many trees presented rather poor subjects with which to deal. The removal of numerous hopeless

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specimens was necessary to eliminate the undesirable evidence of our previous efforts. This group of experts continued during the year 1929, pruning approximately five thousand trees extending over eighty miles of transmission lines. The work was all accomplished without a single complaint from the adjacent property owners—something which can rarely, if ever, be said of our previous methods. Many nature lovers, who recognized the ability of the men employed and the interest manifested by the Commission in public property and roadside beauty, have since written commendatory letters expressing their gratitude for this advanced step.

Further experiments continued in the year 1930. Two competitive organizations were employed, pruning slightly more than seven thousand trees along some three hundred and forty miles of Provincial Highways, with much the same results as were accomplished during the year 1929. The Department of Public Highways have shown their appreciation for this progressive step, in their willingness to co-operate with these experts working under our direction.

In analyzing the results and far-reaching effects of the work accomplished by trained men dealing exclusively with trees, it has been found essential to know something about the subject. Therefore, every man must be given a thorough training in the practical methods of scientific tree pruning as well as a certain amount of theoretical knowledge of the life of trees, not only that he may do his work properly, but in order that he may talk intelligently with the adjacent property owners when securing permission to prune both publicly-owned and privately-owned trees in front of their propreties.

The Commission realized the magnitude of this problem and the satisfactory results of their experiments during the past two years, both in the improved appearance of the trees and the favourable reaction manifested by the property owners. The next logical step was to bring this desirable activity within their own organization—as other large public utilities have done—which was definitely decided upon in July, 1930. To further substantiate the Commission's action in establishing the Forestry Division, we shall reprint two excerpts from the N.E.L.A. Publication No. 110, dated January, 1931, entitled "Tree Trimming Practices":

"The net work of overhead electric supply lines being installed by utility companies on street and highways throughout the country, coupled with the natural desire of the public to

Maple pruned to clear line on right hand side of road. Pruning on left hand side to balance the tree cleared it from foreign line on that side.

have shaded boulevards and beautiful landscapes, has presented a problem that demands the closest co-operation between the two parties concerned for the conservation of both trees and electric lines. Therefore, it must be borne in mind that the satisfaction or disapproval of an entire community is directly affected by a company's tree policy.

"Trees are important to the owners for shade, for their beauty, for sentimental reasons, and they add real value to the property. Even though representing highly material and aesthetic value, the tree may be trimmed without offense, if the owner has confidence in the trimmer, and the necessity for trimming has been properly explained.

"The tree problem, therefore, is a responsibility shared by the utility and the public. The public requires the existence of trees in the proximity of the utility's lines and at the same time expects to receive a quality of service that the utility cannot furnish unless certain portions of the trees are removed."

"Summary—The subject of tree trimming from the electric company's viewpoint is firmly fixed under three principal thoughts which should be kept in mind and followed for successful performances.

"1. The work must be performed in a safe manner.

"2. To realize any benefits from tree trimming it must be thorough enough to keep the trees clear of the lines for more than a year.

"3. The trimming must be done in such a manner as not to mar the appearance of trees in order that proper public relations may be maintained and permission for further

Tree Crown pruned to clear line overhead.

necessary trimming may be obtained if required.

"The first is probably best effected by having a foreman or sub-foreman in charge of the crew that is a real safety man. Give him proper instructions and equipment and he will give you safe tree trimming.

"The second and third points are best effected by following the practice of some of the member companies who have placed the work of tree trimming into a special department which is headed by a man who has had thorough experience along this line. The alternate to this practice is to contract the whole or part of the season trimming to a professional tree trimming company."

While the Forestry Division has been established as an integral part of the Operating Department where the major portion of its work will be required, they are available to all other departments of the Commission as well as the municipalities, and can be secured on reasonable notice.

Trees under pruned to overhang line.

Factors in the Design of 115-230 Volt Distribution for Modern Residential Districts

By G. L. Lillie, Distribution Dept., Toronto Hydro-Electric System.

(*Abstract of paper given before Toronto Section, A.I.E.E., March 27, 1931.*)

A GREAT deal of attention is being paid at the present time to economical and efficient methods of supplying high density load developments in our downtown districts. By this I refer, of course, to the low voltage a.c. networks now being installed in our principal cities. My attention, however, has been drawn to the lack of information on the most advantageous means of supplying those residential districts where the use of electric ranges and water heaters is becoming universal. The question then arises as to what capacity our distribution transformers should be, at what spacing they should be located and what size of secondary copper it would be most economical to use? These appear to be real problems, and it is on the result of a study of these considerations that the following remarks are based.

Due to the rapid increase in the use of electric ranges, water heaters and other appliances, we are continually approaching the point where our secondaries and transformers are becoming overloaded. Will simply replacing them with larger sizes remedy these conditions? Possibly, but how long before they will require further changing? Might there not be some more satisfactory arrangement by which better results could be obtained at a lower cost? In laying out the distribution for new districts, what loads should be expected and how best supplied? Some policy should be adopted which will at least serve as a guide to follow as far as it may be practical. It is well known, of course, that many things cannot be accomplished on the job which look very fine on paper.

Our first need then is for advance information on what loads to expect in the modern residential district. Many tests have been made in various parts of the city to ascertain the amount and duration of the daily load. All classes of dwellings have been included in the survey from the humble cottage to the lordly mansion and the accommodating double duplex. We have, however, limited our attentions to districts built up in recent years.

Recording ammeters have been used to give us daily load curves on each side of the three wire secondaries and a personal count has supplied information on the connected load, size and spacing of houses, whether occupied or not, and the extent of vacant property on the street in question. In Fig. 1 we have typical examples of heavy residential load. Notice the maintained nature of the peak. The chart on the right illustrates the high Monday wash day

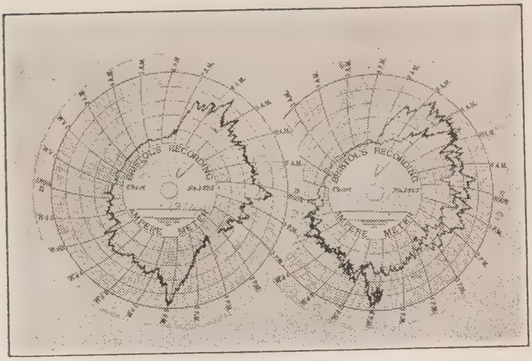


Fig. 1

characteristic that can always be found where many electric water heaters are used. On the left, Tuesday's ironing day is almost as high, but all days of the week do their share in building load where we have ranges and water heaters in large numbers. Even Sunday's peak, if a bit late in getting started, is up to the top from ten until after noon. In Fig. 2 I have tried to get a picture of a number of similar charts re-drawn on a horizontal base and super-imposed one on another. The only time when there appears to be a valley in the curve (other than at night) is at about 3.30 p.m., just before the kettle goes on for afternoon tea.

In Fig. 3 we have data from some of the districts tested and also the results arrived at. In the first column are listed the number of consumers on each circuit at the time the test was made. This does not include disconnected services, vacant apartments or buildings temporarily unoccupied. In the next column we have the number of ranges and adjacent to that I have shown what percentage these ranges make to the total number of consumers. Then follows a column of the number of water heaters of 3 kw. or over. In some districts this load is becoming of even greater importance than the range itself. After this is shown a column headed "Possible Ranges," i.e., the number of ranges we would have if all vacant properties were built up with similar type residences and equiped with electric ranges, including as well those buildings now vacant, or where other means of cooking are used; in other words, assuming all possible consumers on a fully built up street to be 100 per cent. electric range users.

Next, we have the connected load which is the sum of the range and water heater capacities in kw., together with an allowance of .8 kw. per consumer for all other appliances and lighting loads. This latter I consider to be a very conservative figure. Following this is a column for

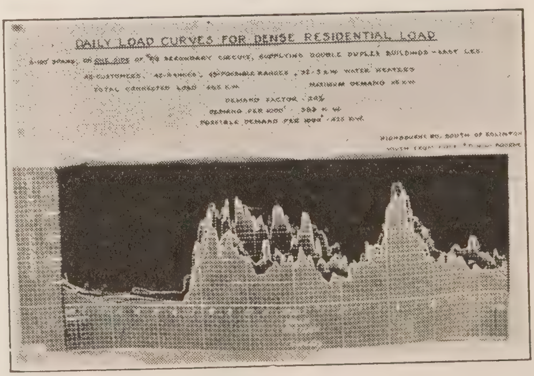


Fig. 2

demand factors, being the maximum demand expressed as a percentage of the connected load, or the ratio of the maximum demand on the line tested to the connected load. Then we have worked out the maximum demand for 1,000 feet of similar street, and from this a possible maximum demand per thousand feet is calculated by taking the possible number of ranges instead of the existing number and assuming the proportion of water heaters to be as at present.

	#	Customers	Ranges	% Ranges	Water Heater	Possible # of Ranges	Connected Loads	Maximum Demand	Secondary Spans & Sizes	Demand Factor %	K.W. Demand per 1000'	Possible Demand-1000'	
A	1	34	17	50		34	130.5	43.7	7* 0	33.3	62.4	125	1920
B	2	39	18	46		39	151.5	47	7 2	31.5	67	145	
A	1	28	13	46.4		28	112	39	5 0	34.8	78	168	1928-9
B	2	50	25	50		50	241	57.5	7 0	23.8	82.1	164.2	
C	3	56	22	39		56	222	48.3	7 0	21.7	69	175.5	
D	4	21	18	86		24	162	39	5 0	24	78	104	
	5	28	28	100		56	248	46	3 0	18.5	153	306	
	1	17	16	94	7	18	162.6	51.75	4 0	31.8	129.3	145.4	1930-1
	2	15	13	87	3	16	.125	59.8	5 0	47.8	119.6	147.2	
	3	17	12	71	4	18	121.6	50.6	5 0	41	101.2	151.8	
	4	26	19	73	9	26	200	46	4 0	23	115	157	
	5	25	19	76	10	25	202	48.3	4 0	24	121	159	
D	6	22	18	82	12	24	197.6	59.8	5 0	30.2	119.6	159.5	
	7	9	7	77	5	12	78.2	29.9	3 0	38.2	99.6	170.7	
	8	29	21	72.5	2	45	197.2	46	6 0	23.2	76.6	164	
	9	31	19	61.2	5	31	191.8	46	4 0	24	115	188	
	10	23	6	26	1	25	69.4	13.8	3 0	19.8	46	192	
	11	33	19	57.5	4	34	190	43.7	4 0	23	109.2	195.5	
	12	35	23	66	5	37	227	63.3	5 0	27.8	126.6	203.6	
	13	18	13	72	9	18	145.4	59.8	4 2	41	149.5	207	
	14	33	20	60.5	8	34	210.4	63.3	5 0	30	126.6	216	
C	15	35	13	37	5	31	147	46	5 0	31.2	92	219	
	16	19	19	100	15	37	216.2	66.7	5 0	31	133.4	259.7	
	17	18	18	100	14	36	199.4	55.2	4 0	27.6	138	276	
	18	34	34	100	27	49	380.2	80.5	3 2/0	21	268	387	
	19	42	42	100	32	49	465.6	115	3 2/0	24.7	383	446.9	

Fig. 3

On the first two lines I have repeated the results of two tests made in 1920 and these were again checked in 1929. An increase in maximum demand has been obtained but on account of these being older houses, the possible demand is yet far from being reached. These streets were early leaders in the use of electric ranges but now their load is small compared with newer districts. In section No. 3, tested in December, 1928, we have 56 consumers, 39 per cent. of whom use electric ranges. The maximum demand obtained was 48.3 kw. giving a demand factor of 21.7 per cent. As this was for seven spans, the demand per 1,000 feet would have been 60 kw. and supposing some day all the consumers were to use this energy for cooking, we would then have to figure on 175.5 kw. In this case all houses were detached of six or seven rooms, $7,000 to $8,000 in value and on lots averaging 30 feet in width. This section was again checked this year as shown on line No. 15. The length of the secondary feeder has been reduced, there are fewer consumers and the percentage of ranges has decreased to 37 but the demand is up to 92 kw. per thousand feet. This is the sort of growth we have in districts where houses have been built ten years or more. In most cases these buildings were not originally wired for the present day electric heating load.

In No. 1 of this season's tests we have large modern residences of $15,000 to $20,000 in value on lots of 50 feet or over in width. You will note that although we have only 17 consumers on 400 feet of line, sixteen of them, or 94 per cent., have electric ranges. There are also 7-3 kw. water heaters installed. These we did not previously bother to list, but now they are affecting the load so much that it has become necessary to take notice of them. One vacant lot makes a possibility of eighteen ranges at some future date, and this, I may state, is more than a probability. This gives a present maximum demand of 129.3 kw. and a possible of 145.4 in spite of the greater spacing of buildings.

In tests No. 16 to 19 we come to duplex and double duplex dwellings. When tests were made on section No. 16 nearly half of the apartments were either unoccupied or buildings were not completed, but as we actually obtained 290 amperes on peak on No. 0 secondaries feeding 500 feet, it was clearly necessary that some changes should be made. This, in general, has been our experience to a more or less degree throughout these investigations.

In No. 17 we have large duplex residences with again only one side of the street built on. No. 18 and No. 19 represent the same district tested at two different times. These are five and six roomed double duplex buildings on about 50 or 55 ft. frontage. Our first test was made in May, 1930, with only 34 consumers. In October we repeated this test as the load obtained was the largest yet found in residential districts. The number of consumers had then increased to 42 with a strong possibility of 49 in the near future. This would give a grand total of 446.8 kw. per thousand feet, or higher, as our meters went off scale at the reading of 500 amperes which we used for purposes of calculation. From this we see that maximum demands of from approximately 75 to 200 kw. per thousand feet may be expected on fully built up streets, varying, of course, with the percentage of ranges installed. Where duplex residences are located in blocks, the load may be more than twice this amount.

It may be news for some of us to know that in 1910 when the Toronto Hydro-Electric System was being started a maximum demand of 6 kw. per thousand feet was considered adequate for residential districts and No. 6 secondaries were planned for this purpose. In 1920, 75 kw. per thousand feet was thought to be the maximum demand and now we can practically call it a minimum where we have to supply any number of ranges at all. So if we then have an increase in demand from 1910 to 1920 of say 70 kw. per thousand feet and from 1920 to 1930 another jump of 100 kw. per thousand feet, what development should we expect in the next ten years?

Now that we are acquainted with the various types of load and districts which we are likely to encounter, let us go back to the original question, namely what is the most economical method of supplying these loads? If we were to tabulate the annual carrying charges per thousand feet of different size secondaries together with their I^2R losses, and the carrying charges and losses of the transformers necessary to supply a given load per thousand feet, at various transformer spacings, then we will, by picking out the minimum total charges, be able to form an opinion as to the most economical combination of sizes and spacings to use. For purposes of comparison, we have taken No. 2, 0, 3/0, 4/0, 300 MCM, and 500 MCM to be standard conductors and transformer spacings to be 400 feet, 600 feet, 800 feet, 1,000 feet and 1,200 feet. Annual carrying charges per thousand feet on the above secondaries were taken as 10 per cent. of the labour and material cost of erection and include interest, depreciation and sinking fund. The neutral is assumed to be

the same size as the outer conductors. Similarly, transformer charges per year were figured at 13 per cent. The annual energy losses in secondaries and transformers is valuated at 1 cent per kw-hr. Energy loss can be calculated by using the maximum demand for a number of peak load hours daily over a yearly period. This number of hours would represent the length of time that the peak load current would have to flow in order to equal the same energy loss that the variable current shown on the chart creates in 24 hours. From analyzing a number of charts we have taken three hours to be a fair average value but, as will be noted later, tables have been worked out for comparison on the basis of 2, 3, 4 and 5 hours. The charts shown in Fig. 1 had energy values equivalent to approximately four or five hours of peak load.

As a general case, we would assume the load to be uniformly distributed in two directions along the secondary feeder from the transformer to a middle point between transformers or to the end of the secondary section, and for 1,000 foot spacing the energy loss would equal one-third of I^2R x 2 x number of hours yearly. In practice, however, we really have two conditions which are illustrated in Figs. 4 and 5.

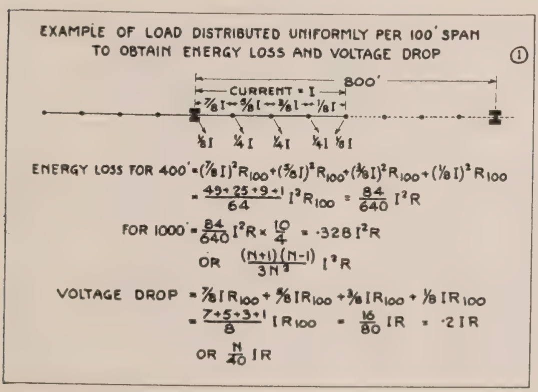


Fig. 4

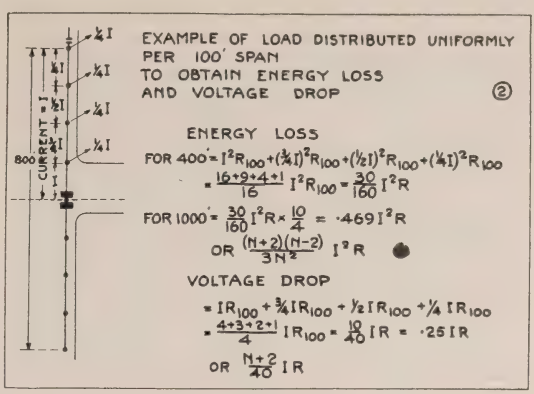


Fig. 5

In Fig. 5 is shown arrangement of secondary lines where it is assumed that no current is taken off the line at the transformer pole; that is, it all passes from the transformer to the first pole and is then withdrawn in equal quantities from each succeeding pole. This, I believe, more nearly meets the condition, where lines are run across a street from transformers to supply a number of services on a side street. Secondary breaks are usually on one side or other of a pole, and I have assumed the same amount of current to be taken from the end pole as from the others. This will give us maximum energy losses and voltage drops for balanced and uniformly distributed

ANNUAL CARRYING CHARGES PER 1000 FT. OF SEC. CIRCUIT
LOAD 75 K.W. ①

	WIRE CHARGES	SEC. LOSSES	TRANS. LOSS	TRANS. CHARGES	TOTAL CHARGES	VOLTAGE DROP	TRAN. SIZE	SPACING
2	19·78	4·82	12·50	137·50	174·60	1·06	2-10	400'
0	29·26	2·95	"	"	182·21	·65		
3/0	43·10	1·86	"	"	194·96	·42		
2	19·78	11·05	13·33	116·05	160·21	2·38	2-15	600'
0	29·26	6·91	"	"	165·55	1·5		
3/0	43·10	4·33	"	"	177·01	·94		
2	19·78	19·86	12·50	101·25	153·39	4·24	2-20	800'
0	29·26	12·43	"	"	155·44	2·66		
3/0	43·10	7·81	"	"	164·66	1·67		
2	19·78	31·32	12·00	91·51	154·61	5·65	2-25	1000'
0	29·26	19·58	"	"	152·35	4·15		
3/0	43·10	12·27	"	"	158·88	2·61		
2	19·78	45·15	11·66	85·83	162·41	9·55	2-30	1200'
0	29·26	28·32	"	"	155·07	6·0		
3/0	43·10	17·77	"	"	158·36	3·75		

Fig. 6

load as compared with the previous case. In obtaining charts for load data all meters had to be installed on secondary lines as per this arrangement.

Now let us take 75 kw. per thousand feet of secondary as a convenient unit of load or maximum demand, and allowing for an overload of 50 per cent. on peak, the transformers required to supply this will be 2-25 kw. (in series). For other transformer spacing than 1,000 feet, and using the same ratio of load to capacity, it becomes a simple matter to calculate the size of transformers required.

We can now make up a table of annual carrying charges for both secondary lines and transformers including their annual energy losses at different transformer spacings and using different size conductors. Fig. 6. This is for a load of 75 kw. per thousand feet. Similar tables have been made using loads of 112½, 150, 225, 300 and 450 kw. Also both secondary arrangements have been used and a separate set of tables made for each case. This is for the first type of distribution assuming equal current off each pole including transformer pole. You will note that $152.35 is the lowest total annual charge for this load. You will see that to get this figure we have 2-25 kw. transformers spaced 1,000 feet apart and No. 0 would be the most economical secondary size. Also the voltage drop may be noted as 4.15 on each side of the line which is less than the usual 5 per cent. regulation allowed. In the next table, Fig. 7, which is for conditions of maximum losses and voltage drop where current is considered as all going to the first pole and then being uniformly distributed from each succeeding pole, the lowest total annual charge is $159.01 for the same transformers and spacing and secondary copper size. The voltage drop here is, of course, somewhat higher being five volts as compared with 4.15 in the previous case. From the results of similar tables worked out for different

ANNUAL CARRYING CHARGES PER 1000 FT. OF SEC CIRCUIT
LOAD 75 K.W. ②

	WIRE CHARGES	SEC LOSSES	TRANS LOSS	TRANS CHARGES	TOTAL CHARGES	VOLTAGE DROP	TRAN SIZE	SPACING
2	19·78	9·59	12·50	137·50	179·37	1·59	2-10	400'
0	29·26	6·00	"	"	185·26	1·0		
3/0	43·10	3·75	"	"	196·85	·625		
2	19·78	18·00	13·33	116·05	167·16	3·18	2-15	600'
0	29·26	11·11	"	"	169·75	2·0		
3/0	43·10	6·98	"	"	179·46	1·25		
2	19·78	28·50	12·50	101·25	162·03	5·32	2-20	800'
0	29·26	17·85	"	"	160·86	3·33		
3/0	43·10	11·20	"	"	168·05	2·09		
2	19·78	42·00	12·00	91·51	165·29	8·00	2-25	1000'
0	29·26	26·24	"	"	159·01	5·00		
3/0	43·10	16·55	"	"	163·16	3·12		
2	19·78	57·82	11·66	85·83	175·09	11·2	2-30	1200'
0	29·26	36·22	"	"	162·97	7·0		
3/0	43·10	22·75	"	"	163·34	4·4		

Fig. 7

size loads, we can now form a sort of summary in table form as shown.

In this table, Fig. 8, we have as before for 75 kw. load the minimum annual charge of $152.35. No. 0 Secondary with 2-25 kw. transformers 1,000 feet apart. With 112½ kw. load, the lowest charge becomes $203.60 still calling for No. 0 wire and 2-30 kw. transformers at 800 foot spacing and voltage drop of four volts. With load of 150 kw. economical charge is $251.93 with 600 foot transformer spacing and still No. 0 secondaries. Similarly for 225 kw. the transformer spacing remains the same but 3/0 conductor is required for secondary copper. At 300 kw. the same spacing with 4/0 secondaries gives lowest figure and at 450 kw. 400 foot spacing becomes most economical with 300 MCM for most efficient copper size. In Fig. 9 for No. 2 classification of secondary distribution, very similar results are obtained. The spacing is the same with the exception that at 300 kw. load, 400 feet becomes more economical than 600 feet. Also, secondary copper of a size larger is shown to be more efficient, except at the first light loading. The voltage drop is somewhat higher but within 5 per cent. at all loads. You will note the gradual tendency towards shorter transformer spacing and larger copper sizes as the loads to be supplied are increased.

Now if we wish to consider the effect of using different average daily hours of peak load on which to calculate energy losses, Fig. 10 may be of use. This will also illustrate the different annual charges, secondary sizes and transformer spacing at different loads in the two types of overhead distribution referred to. Here we have the lowest annual carrying charge for each load (to the nearest dollar only) together with the most economical secondary size and transformer spacing for energy losses based on 2, 3, 4 and 5 hours respectively. The results are quite to be expected. As the number of hours are increased the annual

ANNUAL CARRYING CHARGES PER 1000 FT. OF SECONDARY GIVING ECONOMICAL WIRE AND TRANS. SIZE ②

	75 KW	112½ K.W.	150 K.W.	225 K.W.	300 K.W.	450 K.W.	SPACING
MIN. CHARGE	$179·37	$235·45	$280·76	$369·50	$464·51	$643·40	400′
CU. SIZE	#2	#2	#0	#3/0	#4/0	300 M.C.M.	
TRANS " "	2-10 K.W.	2-15 K.W	2-20 K.W.	2-30 K.W.	2-40 K.W.	2-60 K.W.	
V. DROP.	1·59	2·38	2·0	1·87	1·5	2·1	
MIN CHARGE	167·16	216·71	266·02	364·64	465·50	664·22	600′
CU. SIZE	#2	#0	#3/0	#4/0	300 M.C.M	400 M.C.M	
TRANS " "	2-15 K.W.	2-22·5 K.W.	2-30 K.W.	2-45 K.W.	2-60 K.W.	2-90 K.W.	
V. DROP	3·18	3·0	2·5	3·0	2·82	3·17	
MIN CHARGE	160·86	214·58	269·71	377·00	482·34	675·54	800′
CU. SIZE	#0	#3/0	#4/0	300 M.C.M.	400 M.C.M.	400 M.C.M.	
TRANS " "	2-20 K.W.	2-30 K.W	2-40 K.W.	2-60 K.W.	2-80 K.W.	2-180 K.W	
V. DROP	3·33	3·18	3·34	3·52	3·52	5·28	
MIN. CHARGE	159·01	218·69	270·10	393·84	493·88	722·52	1000′
CU. SIZE	#0	#3/0	#4/0	300 M.C.M.	400 M.C.M	500 M.C.M	
TRANS. " "	2-25 K.W	2-37·5 K.W.	2-50 K.W.	2-75 K.W.	2-100 K.W.	2-150 K.W	
V. DROP	5·0	4·7	5·0	5·27	5·28	6·32	
MIN CHARGE	162·97	223·85	288·46	412·82	521·66	759·23	1200′
CU. SIZE	#0	#4/0	300 M.C.M	400 M.C.M.	500 M.C.M	500 M.C.M	
TRANS " "	2-30 K.W.	2-45 K.W.	2-60 K.W.	2-90 K.W.	2-120 K.W.	2-180 K.W	
V. DROP	7·0	5·25	4·93	5·55	5·92	8·9	

Fig. 9

ANNUAL CARRYING CHARGES PER 1000 FT. OF SECONDARY GIVING ECONOMICAL WIRE AND TRANS SIZE ①

	75 K.W.	112½ K.W.	150 K.W.	225 K.W	300 K.W.	450 K.W.	SPACING
MIN CHARGE	$174·60	$224·55	$266·21	$348·46	$437·86	$605·60	400′
CU. SIZE	# 2	# 2	#2	#0	# 3/0	300 M.C.M.	
TRANS " "	2-10 K.W.	2-15 K.W.	2-20 K.W.	2-30 K.W.	2-40 K.W.	2-60 K.W.	
V. DROP	1·06	1·6	2·1	2·0	1·68	1·4	
MIN CHARGE	160·21	207·11	251·93	345·49	436·95	623·97	600′
CU. SIZE	#2	#2	#0	#3/0	#4/0	300 M.C.M	
TRANS. " "	2-15 K.W.	2-22·5 K.W	2-30 K.W.	2-45 K.W.	2-60 K.W	2-90 K.W.	
V. DROP	2·38	3·6	3·0	2·8	3·0	3·16	
MIN CHARGE	153·39	203·60	256·86	355·11	455·02	634·50	800′
CU. SIZE	#2	#0	#3/0	#4/0	300 M.C.M.	500 M.C.M.	
TRANS. " "	2-20 K.W.	2-30 K.W	2-40 K.W	2-60 K.W.	2-80 K.W.	2-120 K.W.	
V. DROP	4·24	4·0	3·33	4·0	3·74	3·4	
MIN CHARGE	152·35	209·09	256·42	373·12	465·98	672·72	1000′
CU. SIZE	#0	#0	#4/0	300 M.C.M	400 M.C.M	500 M.C.M.	
TRANS " "	2-25 K.W.	2-37·5 K.W.	2-50 K.W.	2-75 K.W.	2-100 K.W.	2-150 K.W.	
V. DROP	4·15	6·24	4·18	4·4	4·4	5·28	
MIN. CHARGE	155·07	214·66	272·75	394·17	495·17	699·83	1200′
CU. SIZE	#0	#3/0	#4/0	300 M.C.M.	500 M.C.M.	500 M.C.M.	
TRANS " "	2-30 K.W.	2-45 K.W.	2-60 K.W.	2-90 K.W.	2-120 K.W.	2-180 K.W	
V. DROP							

Fig. 8

COMPARISON OF ANNUAL CHARGES AND SECONDARY SIZE WITH DIFFERENT HOURS OF DEMAND PEAK

CLASS	HOURS OF PEAK LOAD	75 K.W	112½ K.W	150 K.W	225 K.W	300 K.W	450 K.W
1	2	$140 #2 1000'	$189 #0 800'	$235 #0 600	$322 #3/0 600'	$404 #4/0 600'	$572-#300 M.C.M 400'
	3	152 #0 1000'	204 #0 800'	252 #0 600'	345 #3/0 600'	437 #4/0 600'	606-#300 M.C.M 400'
	4	163 #0 1000'	219 #3/0 800'	269 #0 600'	368 #4/0 600'	463 #3/0 400'	641-300 M.C.M 400'
	5	171 #0 800'	230 #3/0 800'	282 #3/0 600'	386 #3/0 400'	487 #4/0 400'	677-300 M.C.M. 400
2	2	146 #0 1000'	197 #0 800'	246 #0 600'	337 #4/0 600'	427 #4/0 600'	597-300 M.C.M. 400'
	3	159 #0 1000'	215 #3/0 800'	266 #3/0 600'	365 #4/0 600'	465 #4/0 400'	543-300 M.C.M. 400'
	4	172 #0 800'	229 #3/0 800'	284 #3/0 600'	393 #4/0 400'	496 #4/0 400'	692-300 M.C.M. 400'
	5	180 #0 800'	242 #4/0 800'	298 #4/0 600'	412 #4/0 400'	524-300 M.C.M 400'	731-400 M.C.M 400'

Fig. 10

charges increase. The copper size is then economically larger (about one size for three hours difference), or else and sometimes also, a smaller transformer spacing (with smaller transformers) becomes more effective.

Now let us take one concrete example of what results we may obtain from these investigations. Suppose we have a street running at right angles to the primary bus on which there are No. 0 secondaries on concrete poles on one side only, feeding approximately 400 feet from the transformers located at the corner and suppose these secondaries are carrying 225 amperes on peak and the transformers are approximately 100 per cent. overloaded and we also have a complaint of low voltage from a customer on this line. This sounds like an extreme example but is just what modern conditions are continually developing. I am referring to an actual case which is No. 1 on the Test Data Fig. 3. The maximum demand is 129.3 kw. per thousand feet with a possibility of 145.4 kw. at some future date based on existing sources of load only. Referring to Fig 9 we see that 300 feet is as far as our secondaries can feed economically and to do this No. 3/0 copper should be used. Also, if we leave the No. 0 secondaries as at present, we can supply this load with transformers spaced 400 feet apart at little extra annual cost. As the block is 800 feet long, a primary extension of three spans and the erection of two transformers on the last pole is all that would be necessary to fulfil these requirements, i.e., relieve overloads on other transformers and lines and satisfy customer by lowering the voltage drop to approximately one volt. This would cost, say $230 as compared with $390, the cost of changing the present secondaries in this block to No. 4/0 with a minimum voltage drop of at least 3.34 (in neither case are the transformer costs included). There are other ways of extending this primary by varying amounts of additional cost. If it is desirable to maintain only one pole line on the street, the existing concrete poles may be replaced with 35 ft. cedars and the single wire primary constructed as before including, of course, the restringing of street and house lighting secondaries. This will take approximately $360. If trees are numerous and much trimming is required or higher poles necessary, this amount may be considerably increased. The unsightliness of large cedar poles, especially where replacing or adjacent to concrete poles in fine residential districts is often a source of complaint from consumers. For some time we have been using

No. 6 P.I.L.C. cable supported on a messenger on concrete poles for making short primary extensions in special cases where trees were a consideration and could not or should not be trimmed. This form of construction is certainly an improvement in appearance over the heavier type of cedar pole line.

Generally this necessitates the replacing of two poles only, the pole on which the transformers are to be hung and usually the end pole adjacent to the primary bus where the strain of the messenger must be taken. The cost of this construction, however, nearly equals the cost of replacing all the concrete poles with wood and stringing open primary wire. We are attempting to develop an armoured primary cable for this use which will not require a messenger, and at present we have several such installations in service. We are experimenting with several types of this cable, one is varnished cambric insulated with jute braid and aluminum alloy wire armour. It weighs 38 lbs. per 100 foot span and was obtained in England. Another from New York is No. 6 solid with 9/64 in. rubber compound insulation jute braiding and also armoured with aluminum wire. A second sample from the latter company is No. 6 solid high-tenso conductor insulated with rubber compound as before and having a 10 mil bronze tape armour covered over all with seine twine braid. These cables are only slightly greater in cost than the P.I.L.C. cable but can be installed at a considerable saving per foot. They are as light as the No. 0 secondary and can be strung on standard insulators on concrete poles almost as easily. Terminals are inexpensive and require no wiped joints as in lead cable. The armour gives better protection from trees and other foreign objects and the appearance is greatly improved.

Up to the present time these trial orders are giving every satisfaction and we expect to use a considerable amount of this material in the future.

We still have the overhead transformers as a prolific source of complaint from an esthetic point of view and no one can concede them to be ornamental. Perhaps some day they will all be buried in the ground. At the present time, however, the extra cost is too great to apply this remedy extensively, but where we have them installed they are proving very satisfactory. Painting transformer cases grey may help to blend them into the background and in at least one instance, green has been requested and used.

Now what general conclusions can be drawn from the foregoing investigation? I would consider that the principal points to note are that with the present voltage of 115-230 for secondary distribution, and considering single phase only we must, in new districts, lay out our distribution lines so that transformers will be spaced at a minimum distance of from 400 to 600 feet apart. Where there are duplex residences to be expected, the minimum spacing must be used. This practically means building primary lines on nearly every street unless the blocks are very small. This, in general, necessitates the use of cedar poles with many transformers and, of course, increases

the possibility of complaints from consumers with regard to appearance. In districts not so new, where 1,000 foot or greater spacings have been previously satisfactory, we are now faced with the necessity of making innumerable short primary extensions and to avoid changing poles, trimming trees and for general improvement in appearance, some type of light armoured cable with grounded sheath may be recommended. As for secondary conductors, from No. 0 to No. 4/0 appear to be suitable sizes, depending on the load and duration of peak. In cases where we already have No. 0 secondaries it would appear to be better to make primary extensions than to change the size of the existing copper. If it were possible to use some higher voltage than at present for domestic service, much greater economy could obtained. Three phase secondary distribution would, of course, improve the capacity of our secondary feeders and where loads greater than 10,000 kw. per square mile are to be expected (and 112.5 kw. per thousand feet would qualify for this load), three phase secondary networks are considered economical. It then would seem for dense residential loads, and especially where we have duplex buildings in quantities, that downtown methods of distribution would be equally applicable.

T.H.E.C. Monthly.

Convention Question Box

(*Questions answered at Association of Municipal Electric Utilities Convention at Toronto, January 9, 1931.*)

TECHNICAL

1. Suppose a three-phase power bank of 3–10 kv-a. transformers 4,000/2,300 to 550 volt, the neutral on the primary side of the transformers is isolated not grounded. The load consists of 1–35 h.p., 3-phase, induction motor, 550 volts, and 1–3 kw., 550/110 volt, lighting transformer. Suppose one primary fuse blows. Describe what takes place.
   (a) With motor operating and lighting being used.
   (b) With motor not operating and lighting being used.

   Is it desirable not to ground the neutral of the transformer bank from standpoint of—
   (a) The consumer.
   (b) The Utility who supplied the service.

Mr. W. B. Buchanan, H.E.P.C. of Ont.—In practice this problem is usually met from the other end, so I will discuss the second part of the question first, "with motor not operating and lighting being used."

Assume that the fuse blows out on the red phase. That would leave the white and blue transformer primaries connected in series across the single phase. Under no load conditions the R-phase voltage would collapse and the voltage on the blue and white drop to 86 per cent. of normal value. You would have

single phase voltage available and no voltage on the red phase.

Suppose you have a load connected and try to take power off the white phase secondary. The white and blue phase transformers are in series and across a single phase. The secondary of the white phase is trying to carry the load, but any current that passes through it draws its equivalent current through the primary, and that must pass through the primary of the blue-phase transformer, which upsets your voltage balance. In any case the load voltage is still less than the 86 per cent. which occurs under no-load conditions.

Now, the first part, "with motor operating and lighting being used."

If you have a 3-phase motor operating on the secondary when the red-phase fuse blows, it would continue to operate drawing power from the two phases, white and blue, and if necessary it would feed back power to the red phase either on those lines, or even, if necessary, on the high tension. Such a system has been used, and we have been able to maintain service on a 2200-volt 3-phase system by operating a motor on the 220-volt secondary. It operates as an induction generator. Sometimes we resort to stunts of that sort, but we would not recommend them as general practice.

The second part of the question refers to a grounding switch.

In my opinion a grounding switch or its equivalent should be provided, but not used under normal conditions. It is desirable to have such a connection available, because the opening of a high tension fuse or the failure of one transformer would still leave facilities for supplying customers on all three phases on the low tension side, also starting torque for the 3-phase motor.

It is rather important that this neutral be stabilized somehow, and if the red phase opens you have to rely on ground current to maintain the voltage on that phase. If you were to try to start your motor under these conditions and with high ground resistance, you would pull the voltage on the low tension red phase down to small value, and as the motor speeds up the red-phase voltage would gradually increase and the motor would act as a generator with balanced three-phase voltages at its terminals.

The latter would not start from rest on single-phase supply only, but when once started would improve the voltage balance on the three phases, which would be particularly valuable if the ground resistance have appreciable value such as 25 ohms.

Operating with the neutral grounded introduces some hazards which should be avoided, particularly if it be of low resistance. A ground on one high tension line would produce a short on the corresponding transformer on the high tension side, and the feed-back from the low tension delta would give rise to excessive mechanical stresses which might destroy the transformer completely.

Further, the excessive load demand might result in serious mechanical stresses in the rotor or winding of the motor while trying to preserve phase balance. These phenomena

might not be destructive in every case, but their possibilities should not be ignored.

* * * *

2. When building 3-phase, 4-wire, 4,000 volt lines, what practice are you following with regard to the neutral? Do you use a solid copper neutral or simply ground the transformer? What should be the size of the neutral with relation to the 3-phase wires? Do you use a galvanized wire for grounding the transformers and what size?

Mr. R. E. Jones, H.E.P.C. of Ont.: A solid neutral, preferably of copper or aluminum should be used throughout from the sub-station to the end of the primary line and should be grounded at each transformer.

There are three reasons for using a continuous neutral, varying in importance according to the local grounding conditions. If the earth is used entirely as the return conductor, a dangerous condition exists when the ground at the transformer becomes poor. In that case the ground rod may be anything up to full primary voltage above the neighbouring soil. The telephone people tell us that the inductive interference to their lines caused by current flowing in the ground is many times greater than from a similar current flowing in an overhead wire. Again, if the grounding is poor, there is a considerable drop in voltage at that point. A couple of years ago I heard of an example, not in Ontario. where a consumer was supplied by a primary circuit with such a ground return. When his motor slowed down, he improved conditions by throwing a pail of water at the foot of the transformer pole.

The size of the neutral will vary with the nature of the load, both as regards its magnitude, and also the balancing of the load on the three phases. It is often necessary to erect as large a neutral as the phase conductors for electrical reasons, and in a great many cases it is the same size for mechanical reasons.

Transformer ground wires should be of copper.

Mr. R. H. Starr, Orillia: I believe I am responsible for part of that question. We have a 3-phase line running out about 12 miles. About 8 miles from the sub-station was a single-phase tap that fed the consumers about a mile down the road. The primary was carried in to the farm yard, and, whether the farmer backed his roller into it or not, the guy wire slacked and allowed the galvanized iron neutral to slack back into the primary wire, and this set up a disturbance of which we were notified by the telephone company at about half-past three in the afternoon. The boys patrolled the line, but did not patrol the line into the farmer's yard. They did not find the trouble until the load got heavier at about seven o'clock in the evening, and it put the telephones in that section out until the trouble was cleared.

The telephone company had the matter up and wanted us to replace that galvanized wire with copper wire, and I wanted to get the opinion of members here.

A Delegate: Do we understand that this primary crossed with a neutral on the farm?

Mr. Starr: Yes.

The Delegate: Were there fuses on the feed in?

Mr. Starr? Yes.

The Delegate: Why didn't they blow?

Mr. Starr: I don't know.

* * * *

3. What grounding, if any, is recommended on the secondary side of 550 volt power transformers?

Mr. A. G. Lang, H.E.P.C. of Ont.: I just want to say that there is no recommendation being made on this question. My experience is that it is not standard practice to ground.

* * * *

4. Where there are current and potential transformers on the top of a pole with 3–75 kw. power and 1–75 kw. light transformers at the base serving an industrial plant, should the lightning arresters be placed one pole ahead of the installation or on the pole with the current and potential transformers.

Mr. S. K. Cheney, H.E.P.C. of Ont.: Developments in the study of surges due to lightning discharges during the past few years have shown definitely that a lightning arrester placed a pole span distant from the apparatus it is supposed to protect will in a great many cases fail utterly to do the work it is supposed to do. These surge voltages have very steep wave fronts with the voltage building up to extremely high values for a period of say 1 to 10 microseconds. A wire 100 to 150 feet in length will offer a high impedance to a current of such steep wave front and before the lightning charge could dissipate itself through the arrester the damage to the equipment will have occurred.

The lightning arrester should therefore be placed as close as possible to the equipment to be protected.

* * * *

5. What is the general practice in towns of 15,000 to 20,000 population of checking transformers and primary line loads? Is this done systematically or haphazardy?

Mr. G. F. Drewry, H.E.P.C. of Ont.: I have talked to a number of the managers of systems in connection with this question and also No. 6.

As to No. 5, there are a number of practices in connection with determining and checking the transformers. The first one, and probably, the one most frequently used, is to have indicating equipment measuring these loads at seasons of the year when the load is at maximum, generally in the fall and winter months.

There are various ways in which the load is measured. Some methods of measurement require little time, measuring when the peak is highest on the system.

Another system is to keep a card index. I know that in the City of Ottawa they keep a very close check—of course it is a much larger municipality than is spoken of here—because they have always had great trouble with the large demand of heater loads. So they have a card index on every transformer—an index of the customers connected with it—so they can have it for reference at

any time. I believe they also make checks on the transformers.

In some cases the investigation will arise out of a complaint of low voltage from a customer.

Another method by which it is done is to check the voltage on the secondary side of the transformer by a graphic instrument, and from this record determine whether the transformer and not the feeder is the cause. Feeders, of course, are measured by a split core transformer and graphic instruments to get an idea of the character of the load on the feeders; but most feeder circuits, I presume, show when the voltage is bad on them, from overload, by the complaints received from customers and the checking of the transformer on the primary side.

Mr. J. W. Peart, St. Thomas: The point raised in Question 5, Mr. Chairman, has been before the meeting on previous occasions, and it has resulted, I think, in most of those municipalities—those between 15,000 and 20,000 population—adopting the use of the graphic ammeter shunted around one of the cutouts on the transformer.

Now, it is true that on a single phase transformer used for lighting you do not obtain the balance on the secondary side of the transformer. If you are concerned as to the balance of the loading you must resort to the use of some arrangement such as a split core transformer, or you can use a graphic meter if you care to. I know three municipalities that are using split core transformers with a demand meter. But I believe that is almost an ideal practice, and not altogether necessary if you follow closely the method in which you connect your services. If you take care, if it is a two-way service, to alternate these, you will practically balance your loading. Then you can resort to metering on the primary side.

As to following this out systematically or otherwise, I think you will find that in the cities mentioned —between 15,000 and 20,000— you will only have 100 to 175 pole type transformer locations, and if you get busy around the 1st of October you will start your testing at a period when the fall heater load is to be encountered. I know that this year we had fairly high temperature in October, and we actually found it necessary to postpone the check-up of the loads on transformers two or three weeks, because that is one factor which must be given consideration. You will agree, I think, that you get the peak at that critical period when the furnaces are not yet lighted and everybody turns on his heater.

With possibly two of those testing outfits you can run over 150 transformers in about 60 days, and I have found that if you do this in the fall you have little to worry about for the balance of the year.

* * * *

6. What system of checking series street lighting systems for burned out and broken lamps do similar towns use?

Mr. G. F. Drewry, H.E.P.C. of Ont.; As far as checking street lighting for burn-outs is concerned, that is left in part by most municipalities to complaints from residents in that

section. In other cases, there is a systematic check at night, when the system is on, by a man in charge of that work. Sometimes this is even done each evening after the lights are put on, by means of a hurried supervision of the whole system. If one light is out in a certain block, the man who is responsible for checking it can readily determine that by the knowledge that he has of the spacing of the lights, and so forth.

M. J. W. Peart, St. Thomas: In regard to Question 6, I think it is just a matter of judgment. I believe it is a very good method to have a man with a truck patrol the street circuits at night and replace burned-out lamps. Street lights are a protection to the public, and if we do not inspect them we are not giving the municipality value for the money.

* * * *

7. What mathematical formula is used to determine economical conductor size on secondaries having regard for voltage regulation? Is price of power considered at substation or distribution secondaries?

Mr. E. F. Hinch, H.E.P.C. of Ont.: I will answer only the first part of this question, and Mr. Wilson will follow with the second part.

I do not know of any mathematical formula that will take care of both economics and regulation. Regulation is not directly tied in with economics.

The procedure in this problem is to make two separate calculations. It is preferable to make the economical calculation first and then check the regulation figures against the required regulation. If the required regulation is lower than your economical cross-section, then you have to put in a conductor that is not an economical conductor.

An economical conductor size is that in which the least annual cost is incurred, the cost including all the costs—loss of power, interest, depreciation, etc.

You might make this calculation by first choosing the size of the conductor, figure the cost of this conductor for a unit length, a thousand feet, or one mile, strung and tied; take the annual charges on this investment — interest, depreciation, sinking fund and contingencies—and calculate the loss of power on this unit length of conductor. Adding the loss of power and the fixed charges, you get the annual cost for this particular conductor size.

Choose another size of conductor and find a similar answer. Compare this with the first size chosen and it will help to determine the choice of the third size. If two is lower than one then try a third on the same side of one as two was chosen. In this way you will find a minimum.

Now, going back to the first matter of choosing the conductor size. There is a formula which will give you sufficiently accurate results to choose your first size; then, using this size for your first calculation of cost, check it against two others, one larger and one smaller. A comparison of these three sizes will give you the lowest which will be the economical size.

Annual charges will include interest, depreciation, sinking fund and

contingencies. Ordinarily I think we use 10 per cent. The calculation of lost power in the conductor is, of course, I^2R and that is multiplied by your price of power.

Mr. J. N. Wilson, H.E.P.C. of Ont.: In connection with the second part of the question, re the price of the power to be considered in your I^2R losses, I think you will be sufficiently accurate if you take the price to the municipality.

Now, if you consider the other side, taking the price to the municipality plus your station costs of say $3 or $4 a horse power per year to step down plus your primary transmission charges of somewhere in the neighbourhood of $1 per horse power per year, plus your fixed charges on service transformer investment to step down to 110-220 volts at say $12 or $14 per kv-a., and the lost power, you would have also to take into consideration anyway your diversity in lighting, which will offset trying to be too accurate on that power price. The result is only approximate anyway; so the general practice is to take the price to the municipality.

* * * *

Business Administration

8. Would it not be possible for Public Utilities to adopt a uniform system whereby a consumer moving from one city or town to another would be required, before being given service at his new place of residence, to present a clearance receipt from the Utility where he had previously resided?

Mr. R. M. Bond, H.E.P.C. of Ont.: I may say that the person who put this question apparently lived in some place where there are no honest people. We still have honest people in the province of Ontario, and I think if that were borne in mind a question like this would not be necessary.

However, we are members of an intelligent body, and it is possible to instal or institute a system to take care of such matters as these if desirable. But is it advisable? At the Accounting session this morning the question of the collection of accounts by one municipality from another dealt very intimately with this subject, and the consensus of opinion was that the percentage of consumers that are affected as far as bad debts are concerned is small. It would therefore seem foolish to cross the bridge before we come to it.

* * * *

9. What authority have the Municipalities for collecting arrears for another Municipality? Has a Municipality any right to discontinue the present service if the old account in the other town has not been paid?

Mr. J. J. Jeffery, H.E.P.C. of Ont.: There are two questions contained in No. 9; to the first I would say yes, and to the second, no.

I would say yes to the first question for the reason that you can appoint any agent you wish to collect your account in any municipality. I say no to the second question because I am advised by our legal department that there is no legislation which would permit you to disconnect a consumer in one municipality for the non-payment of an account owing in another municipality.

However, as long as the customer does not know that, I think there would be no trouble, and usually I think it is a good idea to run the bluff anyway. He is not going to advertise the condition of his finances.

At the same time, I would say that in 95 per cent. of the cases in which you let a consumer get away from you owing you money it is likely your own fault. If you will go back through your records you will usually find that that man has been in arrears a good many times. Quite a number of the systems make it a rule that the drifter, when he has been in arrears more than twice, has to put up a deposit. You always have that relief.

The legislation does not permit you to collect on taxes more than three months arrears for power or lighting bills, hence the reason for getting a deposit from those who are liable to shift suddenly. In some of the border cities, like Sandwich, Windsor and Walkerville, they demand a deposit. There are other places where they are afraid to adopt that method and prefer to swallow the loss. There were so many changing customers in the border cities, however, that they were forced to do something. In one of those cities they have a $15 deposit, and they do not find it any too much; in several others, although they have a $5 deposit, they find it is not enough.

* * * *

10. Is it customary, or the general practice, for a member of local commissions to sign purchase order for any article no matter how small, or for emergency work, in connection with the operation of local systems? Should local managers have authority to purchase emergency material and equipment for ordinary routine business?

The Chairman: A member of our Commission has yet to sign an order for any material of any kind. I would like to hear something on this, because it is a serious matter. What do you do down your way, Mr. Phelps?

Mr. J. E. B. Phelps, Sarnia: The Commission has always given me authority to go ahead and buy equipment, if necessary, up to $1,000, and I have always endeavoured not to abuse the privilege. If a large amount of money is involved the Commission passes on it; in ordinary buying I use my own judgment.

Mr. J. W. Peart, St. Thomas: I think that is a question that pertains more to the smaller municipalities, and that it should be discussed more from their angle than from ours. I should say that managers in towns of from 15,000 to 20,000 have that authority. I know, personally, that if I was to chase up my chairman to get him to sign all the purchasing orders, I would be fired.

Mr. R. H. Starr, Orillia: When I first went to Orillia the amount was $50; it is now $150. Anything above that is supposed to be passed by the Commission. That regulation has been broken more often than it has been lived up to, and generally the requisition has been passed after the account was paid.

Mr. C. T. Barnes, Oshawa: The same thing goes for Oshawa. I have authority up to $500.

Mr. W. E. Swartz, Petrolia: Possibly I have had exceptionally good

Commissions in the past fourteen years, for I have never yet had a Commission bring up a resolution that I must have a signed order before making any necessary purchase. Anything for ordinary operation or maintenance I buy without any resolution of the Commission; for anything requiring capital expenditures running into several hundreds of dollars I make out my requirements and submit them to the Commission.

Mr. G. Kribs, Niagara Falls: I was chairman of the Niagara Falls Commission last year. My attitude, and the attitude of our Commission, is that if we cannot trust our manager and secretary to do the ordinary purchasing it is high time that we got a new set of employees. I do not think it is necessary for the Commission or Commissioners to O.K. any expenditures other than very large ones. The only matters that our Commission has anything to do with are very large contracts, which makes it necessary for the chairman to sign the contract for materials. Otherwise the manager and secretary have carte blanche to purchase materials from whoever they like in any way they like, and to instal them.

* * * *

Rates

11. (a) In case a consumer living in his own house lets some rooms to another family, and in case both have electric ranges, should each be required to make contract with Supply Authority, and should each be metered and billed separately as a 3-wire customer?

    (b) In case the tenant leaves and only one meter and circuit is in use, how long should the owner pay for the extra expense of Supply Authority to provide extra capacity?

Mr. H. D. Rothwell, H.E.P.C. of Ont.: This, I believe, resolves itself into a question of apartment houses. As soon as this man divides the house into two, he has created a duplex, making it necessary to re-arrange his wiring in order to supply the second range or apartment, and therefore it is necessary that he should take out a second contract and that the service be billed separately.

In regard to paragraph (b): He signs a contract according to the Standard Interpretation of Rates for one year, therefore it should be necessary for him to pay a service charge until the contract has expired.

A Delegate: Would you apply that to lighting as well?

Mr. Rothwell: Yes, a domestic consumer; this is a residence that is referred to.

The Delegate: If there is no stove?

Mr. Rothwell: Absolutely. Yes.

* * *

12. Please describe the proper method of charging for the service to electric welders. Suppose power consumer with a power demand for motors of 400 h.p., also welders of 200 kv-a. (nameplate rating) are supplied at the same voltage as the motors. These welders are single-phase but balanced as nearly as possible across the three phases.

    Please describe the type of meters which should be used to measure the welder load.

What would be the difference in method of measurement and method of charging?

(a) When consumer buys power at primary voltage and owns the transformers?

(b) When consumer buys power at secondary voltage and the utility owns the transformers.

Mr. J. J. Jeffery, H.E.P.C. of Ont.: This is a rather unusual customer. I think I know where the question came from. That matter was taken up specially with the Commission, and approval was obtained to change the method of billing from Clause 47 of the Standard Interpretation of Rates.

Clause 47 requires you to measure the total load on a graphic or demand meter and add the total capacity of the welders to the demand so obtained. That was found to work a hardship on the consumer, and after very careful investigation it was changed so as to add 50 per cent. of the variable load to the demand obtained by the meters. The Standard Interpretation of Rates, which will be revised within the next month, I believe, will contain a new Clause 47.

As to the billing of the customer, where he owns the transformers, there is a difference of 5 per cent. That is standard. Where the power is measured at primary voltage the consumer gets the 5 per cent.

Mr. T. R. C. Flint, Toronto: I would like to ask Mr. Jeffery a question. Assuming that there were three 200 kv-a, welders, would he take 50 per cent. of the 600 kv-a. and add it to the demand of the ammeter?

Mr. Jeffery: Yes, unless you can show by actual measurement that it should be more.

* * * *

13. In view of the density of electric ranges in use in some municipalities as compared with the load contributed by power from other sources, are domestic rates equitable?

Mr. G. F. Drewry, H.E.P.C. of Ont.: When this question was taken up it was suggested that the answer was yes. That is a pretty abrupt answer, I know. I do not know exactly what was in the mind of the person who framed the question, but we cannot admit without proper argument that the rates are anything but equitable. If anyone can prove that they are not we are free to change them. We are not wedded to the present scheme of rates and are very anxious to bring them up to date, having in view at all times the fact that when we make a complete revision of the Standard of Rates, it causes considerable disturbance.

In this particular question I presume the inquirer may have in mind the question as to whether the rate, as a domestic rate, is equitable when compared with the power rate. Without going into too elaborate a discussion of the rate structure I may say this: I think that having due regard to the situation, a power customer taking the same demand as a lighting customer is not comparable with the lighting customer, for the one is classified in the group called "power customers", and the other in the group called "domestic customers." If that is the distinction you cannot make a comparison, and the service charges are not comparable.

We all know that our present rate structure provides for three or four classifications of business. The largest is the domestic rate, then following that the power rate, and finally street lighting.

It is possible, I suppose, to some day reach an ideal condition when one rate will cover all kinds of services and when there will be no classification of customers. Let us hope for that, at least. Meantime I think we will have to agree that there are extreme cases in which there certainly does not seem to be any great evidence of equity. But our rate structures are not built on extreme cases; they are built to cover average conditions as they prevail, and if that is kept in mind the answer to this question is just plain yes.

* * * *

14. Is the billing a municipality on the basis of highest 20 minute peak per month, regardless of kilowatt hours consumed, really the fairest way of billing?

Mr. J. J. Jeffery, H.E.P.C. of Ont.: That is perhaps a matter of opinion. In, say, the Georgian Bay System, where they depended largely on water storage until they were connected to the Niagara System recently, the demand basis does not seem to be as fair a basis as the load factor basis. In the Niagara System, where the use of the water developed at Niagara Falls for power purposes is restricted as to the number of second feet permissible, and as the contracts recently made by the Commission for power to be developed on the Ottawa River and also for power purchased from the Gatineau Power Co. in Quebec, are on the basis of 70 per cent. weekly load factor—I believe the Beauharnois is 85 per cent.—you see the way in which the cost of power is affected by the kilowatt-hours used by the municipalities.

I am not in a position to say that the Commission are going to change their method of billing. I will simply answer the question by saying that it would appear to be a more equitable basis to have a demand basis plus a load factor basis. Whatever that would be would require careful study.

Several years ago we got out some statistics in connection with the load factors of municipalities. I will give you some of them, the average municipal load factor over the year: Chatham, 51; Sarnia, 50; St. Thomas, 51.6; Preston, 38.2; Galt, 38.5; Niagara Falls, 47; Hamilton, 55; Toronto, 58. Some of the smaller municipalities are as low as 35 per cent.

O.M.E.A. — A.M.E.U.

SUMMER CONVENTION AT OTTAWA

June 25, 26 and 27, 1931

Guarantee Deposits by Tenants

(Discussion at Accounting and Office Administration Session of Association of Municipal Electrical Utilities Convention at Toronto, January 8, 1931.)

Mr. A. B. Manson, Stratford, Chairman: Gentlemen, you have heard the suggestion offered as a subject for discussion,—that of Guarantee Deposits by tenants. I think this is a subject that will be of perhaps more than ordinary interest at the present time. There are so many men out of employment that a great many tenants probably are not able to make their payments on time, and furthermore, they move from place to place.

Mr. J. W. Peart, St. Thomas: I think that under clause 40 or 42 of the Standard Interpretations of Rates, the local Commission is authorized to set up any schedule of deposits they may deem necessary or advisable. Up until 1927 it was the general practice to overlook the matter of deposits to any defined extent as up to that time we had a certain recourse whereby arrears accruing say by a tenant could be registered on the collector's roll of the municipality as against the property. In other words, the owner of the property was held liable in the final analysis. There was a revision of the Public Utilities Act in 1927 which limited the arrears which could be charged against the property to three months. Therefore, the matter of deposits became acute, since electric ranges came into general use, we have much larger bills to collect than we had say ten or twelve years ago, and since the majority of the municipalities have now adopted the bi-monthly billing, we find that we are faced with the collection of a fairly substantial bill on range service every two months.

Now, as to the practice in my own municipality, we started off with a \$3.00 deposit on a two-wire service, or in fact on any service. That was prior to the adoption of the bi-monthly billing. In 1928, we adopted bi-monthly billing and immediately found that a \$3.00 deposit was inadequate and we immediately stepped it up to \$5.00 on a resolution of our local Commission. Now we find that \$5.00 doesn't cover the situation as far as rental service goes, and in conversation with the managers of some of the other municipalities I find that some are charging \$10.00 for three-wire service, and some have it up to \$15.00. I believe that the point raised is a very important one because it certainly shows that we have some protection against these outstanding accounts, which are now becoming quite substantial.

Mr. H. F. Shearer, Welland: I think that Mr. Peart initiated an idea that will result in benefit to us this afternoon in giving us the experience of each in his own municipality. Previous to 1924 we had no provision for deposits at all in Welland, and we followed the 1924 final payments as closely as we could, and even in the first three months of 1925 we still sought to collect the final payments on bills, but we had to report a loss of between \$300 and \$400 of uncollectible finals, and when

that report was made a resolution was immediately passed authorizing the institution of a deposit system for tenants. This was established at that time at $5.00 for a two-wire service and $10 for three-wire, regardless of whether it was domestic or commercial service. Those figures still stand with us but there are many cases where they are hopelessly inadequate because the consumption now runs up to 200 or more kilowatt-hours per billing period. Our commission have talked over this situation but have not arrived at any decision, but our experience has been that since the institution of the deposit system we have lost not more than one-tenth of one per cent. of our revenue of either class of service. At the present time nearly all of our moving tenants have been placed on a deposit system. It has worked out very satisfactorily.

Mr. A. B. Scott, Galt: This matter of deposits has been before us on two or three other occasions, but no rule has been laid down. Our losses have been comparatively small. While I am on my feet may I ask if it is the custom to pay interest on the deposits.

Mr. Peart: We pay no interest on deposits under $5.

Mr. Scott: And are you requiring all consumers to make deposits?

Mr. Peart: Just tenants.

Mr. Scott: Whether they are moving or not?

Mr. Peart: Any consumer occupying premises he does not own.

Mr. Scott: Did I understand Mr. Shearer to say that they are just collecting from tenants as they move from one location to another?

Mr. Shearer: As long as they stay in one premises we can collect their accounts. The deposit is to guard against escaping payment of final bill.

Mr. Peart: We have tenants who have been occupying premises for say twelve or fifteen years. We have not demanded the $5 deposit from them, but we do get it from them when they move and also a new contract.

Mr. I. N. Pritchard, Chatham: I would like to ask one or two questions. In our part of the Province the question has come up several times regarding what amount is recommended by the Provincial Commission for tenants' deposits. In one municipality they have been charging $15 for a residential consumer, and it appeared in one of the local papers that the Hydro Commission recommends only $5, and that question has been under discussion for several weeks. I would like to know what the Hydro Commission do recommend in the way of a deposit on domestic and commercial service.

In connection with collecting deposits from range owners, is it not a fact that a large percentage of them own their own homes?

After you have run your Consumers Deposit Account for several years and you find that a large percentage of tenants have moved out of town and you try to trace them and can't find them, how long are you going to keep their deposits and what are you going to do with them? I understand that in some places they take them and apply them to some outstanding arrears against some other person.

Mr. J. C. Johnston, Etobicoke Twp.: Possibly I can answer those questions. We have been collecting deposits for the last five years. Sometimes deposits have not been called for and we go through the deposit ledger and pick out the accounts that haven't been active for the last two years and place them on what we call an Unclaimed Balance card, the result being that deposits not used for two years accumulate on one deposit card. If at any time it is necessary to go back we find them on the Unclaimed Balance card, and make the adjustment from that. When a consumer leaves the township or municipality, nine times out of ten he wants the deposit refunded within sometimes forty-eight hours. Our Commission has given us the privilege of issuing cheques up to the amount of $25.00 on the signature of one member of the staff. That facilitates the returning of these deposits to these customers within twenty-four hours of the time the account has been closed.

Chairman: May I ask how long you carry those deposits? Have you any set time?

Mr. Johnston: We have to carry them indefinitely.

Mr. L. E. L. Davey, Palmerston: What is done with the interest on these deposits? Is it returned to the consumer or credited to his account, or is it put to the general fund of the municipality?

Mr. R. M. Bond, H.E.P.C. of Ont.: Mr. Pritchard asked the question concerning the amount recommended by the Provincial Commission in connection with the tenants' deposits. I don't think that any specified amount has definitely been stated as applying to every municipality, but the statement that has been made is that the consumers' guarantee deposit should cover at least a two months' bill. That, of course, enables the local Commission to gauge the amount they should get in order to cover local conditions.

Mr. Peart made reference to the Standard Interpretations of Rates and quoted Section 42. The section he should quote is Section 50. That section covers payment of arrears. If we follow the interpretations along that line and deal with it as set forth, the local circumstances and conditions must be taken into consideration. The guarantee deposits should be at least large enough to take care of a two months' bill.

Now about the deposits by range consumers. Mr. Pritchard mentioned that most of the range consumers are owners of their own homes. We do not collect any deposits from the owners. We are dealing only with tenants' guarantee deposits. Where a tenant has a range your deposit must be set at an amount to take care of the bill.

He also mentioned the transfer of deposits unclaimed. We must bear in mind and treat very seriously the fact that these guarantee deposits are trust moneys and they do not belong to the municipality until the consumer is in arrears. If the consumer has left the town and has a clear sheet and has not called for his deposit, that is still trust money. It doesn't belong to the Utility. If this fact is borne in mind there won't be any difficulty in this connection and there will be no danger of the

amount being applied against someone else's account. The safest way to deal with this money is in a separate bank account, calling it "Trust Account".

Now in connection with the refund to the depositors, if we establish this trust fund we must certainly provide some way of giving the money back to the party depositing that money in the first place if he is entitled to it. Mr. Johnston's idea of it being refunded on the signature of a clerk is all right. The local Commission certainly do not wish to be bothered with frequent demands for cheques to be signed and the secretary is in most cases a trustworthy person, so this matter could be handled in the way outlined.

Chairman: Just how much arrears should accrue in any one year before this system should be put into force? Probably certain municipalities have had experience along that line and can give us that information.

Miss Mary Grant, London Twp.: May I mention a case we had in London Township a couple of weeks ago. To some of the tenants in the suburbs $5 is a lot of money and sometimes it is just difficult for owners to rent their houses when we demand $5 from the incoming tenants. A certain man came into our office a couple of weeks ago and said a tenant was moving into one of his houses. There were accrued arrears to the extent of four months—three months of the tenant's and the month the house had been vacant. He paid the amount and I said "what about the $5 from your new tenant?" He said, "No, I don't want you to ask the $5 from this man—I want the house occupied, but I will sign a contract for this tenant." What would you do in a case like that? Would you let the owner sign the contract?

Chairman: If the owner is willing to sign the contract, that clears the matter up immediately. I might say with reference to that, in a few cases we take a second signature,—that is, the owner's signature as guaranteeing any arrears, and in that case we waive the claim for any deposit.

Mr. D. J. McAuley, H.E.P.C. of Ont.: In regard to the matter of the landlord signing the contract, I am of the opinion that the Act at the present time is so constituted that unless the owner signs as the consumer and receives the bill as the consumer, you cannot hold him for tenants' bills. If you render a bill to the tenant, the tenant is the consumer and the only way you can collect from the owner is by the owner receiving the bill as the consumer. The Act states "supply to him there" and if it is supplied to the tenant he is the consumer and the owner gets out from under. The only way you could recover is suit on his guarantee.

Mr. W. E. Swartz, Petrolia: We do not have the owner sign a contract if the tenant has not the money or does not want it signed. The owner signs a guarantee form with regard to lighting accounts up to $5.

Mr. W. G. Hanna, Legal Dept., H.E.P.C.: The guarantee has just been mentioned. What we are trying to grapple with here is the conditions by which the landlord becomes liable for the lien, a three months' lien that you have under the Public Utilities Act,—then if the landlord is made

liable the tax is on his land. Mr. McAuley made the fairly strong statement that the landlord must be the consumer. I am rather inclined to differ a little from him in regard to sending a bill to the landlord. If you have two people on that contract as consumers, they are each liable, and you send a bili to the premises where the light is delivered. The landlord has an interest in the premises, so has the consumer, and the landlord has contracted with you to pay that bill with the other man. If the other man does pay why that lets the landlord out, but it seems to me that would be a sufficient compliance with the Public Utilities Act as it now stands so that the three months' lien would attach on the property. I think perhaps what was bothering Mr. McAuley was some of the difficulties on the Essex border, where the tenants change rather rapidly. As a matter of convenience, it is sometimes better that the bill should be rendered to the landlord.

Mr. H. J. McTavish, Toronto: Is it necessary to have a signed contract at all in order to collect under this lien? My idea is that the acceptance of the current is the contract. If the tenant takes the current do you have to have anything in writing with a signature in order to collect?

Mr. Hanna: The point raised by Mr. McTavish is correct within very strict limits. If the consumer is the owner of the land and the current is delivered to him at his premises, the statutory lien attaches on his land, but as I understood the discussion, it was around the question of tenancy, and as we all know the monthly tenant has an interest in the land that is of practically no value to the Utility whatsoever, because you couldn't realize on any lien. That is why you need a contract for the landlord to sign, but it is quite correct, as Mr. McTavish states, that if the current is delivered the receiver of that current is liable and if he has a sufficient interest in the land, such as an owner, then by the Statute, the lien attaches.

Chairman: There is one question that I have not had any comment upon, that is, when a deposit is taken is any interest allowed on that deposit?

Mr. Bond: I think that is a question of equity. As I said before, the tenants' deposits are trust funds. The Utility collects these as a guarantee, and the depositor is certainly entitled to at least bank interest. Put ourselves in the place of a depositor, would we expect to obtain interest from the Utility if we were in that unhappy position?

Mr. W. E. Wallace, Windsor: I would like to say that in our city we paid 3 per cent. up to January 1, 1930. At that time our Commission made a rule that we pay 5 per cent., and that is the rate we are now paying on all deposits.

Mr. Bond: I would like Mr. Wallace to make the point clear why more than bank interest?

Mr. Wallace: If the money is properly invested in debentures, we can easily make 5 per cent. and we feel we can pay it to them.

Mr. McAuley: I rather think that in Windsor the consumers' deposits are not kept in a separate bank account and those funds are no doubt being used by the Utility all the

time, and if they were borrowing money from the bank they would have to pay the bank 5 per cent. or perhaps more. No doubt in that case they should pay a higher rate of interest than if they had a trust account. If the money is in a trust account, however, I think they shouldn't pay more than 3 per cent.

Mr. Wallace: We have to pay the bank 5½ per cent. We are using the money in the regular bank account.

Mr. D. B. McColl, Walkerville: In Walkerville we charge $5.00 except in the case of summer consumers, who pay $10.00. We pay no interest. In Sandwich I understand they charge up as high as $15. It is a subject we have had under consideration for some time and it is rather hard to form a very definite opinion. At the first of last year we installed a billing machine and we have revised the work of our collection department very materially. Now, with the machine operating smoothly we are spending more time on collections, and we hope within the next three or four months to be able to make an analysis as to just what our delinquent accounts amount to. There is a question in my mind as to whether the Hydro, like every other business concern, should expect to take a certain loss? For instance, when you compare your delinquent accounts at the end of the year with your cash discount forfeited, you find you are usually well to the good, so if you take it in one place probably you can expect to lose it on the other hand. Then, I like to think of what the customer thinks of us. When a man walks into our place, the average consumer, he will give you anywhere from $20 to $50 a year revenue. If you are in the grocery business and have a customer who gives you that amount of business you treat him with a great amount of respect, but when he comes into your local Hydro office he says, "I want to give you some business." We say "That is lovely, but we don't think you are exactly honest." Right off the bat you tell him you are a little bit suspicious of him. When you analyse it a little bit further you find that at the very outset there are not more than 5 per cent. who are going to beat you, but you tell the other 95 per cent. you are suspicious of them. I wonder just how sound and consistent we are? Couldn't we possibly gain more if we went at it the other way and said we will believe everybody is honest until we find him guilty. Just the minute we find a man becoming delinquent in his accounts we can go after him. In the meantime, we know approximately how much revenue he has used and we know what size deposit we should collect. Some men will need $12 or $15, or possiibly more than that. You have a man with an $18 account and you find he doesn't pay promptly. If you have to disconnect him, do not give him service until he pays it. You may suffer a small loss, but then you are asking only the man whom you know is bad to make the deposits. You are not asking 95 per cent. to make deposits in order to protect yourself against the other 5 per cent. I have not formed any definite opinion on that myself, but I sometimes think we do not try to grasp the viewpoint of our customers. In the work of

the Hydro System we want to make friends of our customers if we possibly can. That might be a medium of increasing the friendly relations between the Hydro and the consumer.

Chairman: That is just the reason I asked for some discussion as to what amount of arrears or delinquency should be required before this scheme might be put into effect. Now, I would like to ask someone who has recently put this scheme into effect to tell us what is the reaction on the public? Do they resent it or do they take it as a matter of course?

Mr. Peart: It has been mentioned here previously, Mr. Chairman, that we are all up against the local conditions. You will probably find that where there are Light, Gas and Water Utilities, all municipally operated, you have to be guided to a certain extent in the policy of asking for deposits by what the other departments are doing. In St. Thomas, the Gas and Water departments demand a deposit just as our own department does and it is bound to work out fairly easily with three Utilities.

Then as to the reaction on the public, I believe that there is not one in twenty who puts up any protest other than the mild question as to what it is all about when he is asked for a deposit of $5. I think in this question of deposits we should look further, get away from the publicly owned Utilities and bear in mind that the private Utilities are also enforcing the deposit system.

Mr. Shearer: Mr. McColl's reference to not asking deposits from all is perhaps not the part we should look at. It is the chap who is not particular about telling where he is moving to that we are after.

Chairman: I would like to ask Mr. Shearer what percentage of the people move away without paying their accounts?

Mr. Shearer: Well, we have had the deposit system in operation since 1924. Previous to that time, as I said, for one year, the number of accounts we had in that time, about 1,600, we had between $300 and $400 in final bills which we were unable to collect.

Mr. H. T. Macdonald, H.E.P.C. of Ont.: I would like to ask, Mr. Chairman, if those accounts were for two months in arrears or for longer?

Mr. Shearer: There would be very few over fifteen days or two months in arrears. Most of them would be for a fraction of a two months' bill.

Mr. A. C. Herrington, Strathroy: We find all kinds of customers. If a man comes in and says he can't pay and wants light we give him light anyway. We tell him we will put a portion of the deposit on his next bill and we do it and we generally get it. On the other hand, we have the fellow who skips out. All you can assess against the property owner is three months. You are billing every two months. If you don't go after the man two months behind—if you let him go until he is two months further behind and he can't pay it, what are you going to do for the other month?

Mr. McAuley: If Mr. Herrington follows out the Standard Interpretations of Rates, you won't have the other month.

Mr. C. A. Walters, Napanee: I operate two Utilities in adjacent towns and I happen to be able to compare the operation in respect to the necessity of asking for deposits. Fortunately, in my own town—Napanee, I would say 90 per cent. of the people own their own homes and we have very little difficulty as far as collection is concerned. On the other hand, in the other municipality, a very small percentage own their own homes and we have found since we have forced the necessity of making a deposit that we lose very little money as compared with what we lost before. I think in municipalities where a good many tenants are located the deposit is necessary.

Mr. Davey: Since making the practice of collecting deposits from tenants we have had some coming in and asking us what is going to be done with the money and are we going to get the interest on it? They seem to resent the idea of making deposits only on the ground that they are not going to receive bank interest on their $5 or $10 deposit. Take a town like Palmerston, a railway town, with the depression of railway business all over the country, people have been moving from place to place, and it has been almost impossible to keep up with the tenants. To make ourselves sure we enforced this rule on the 1st November, 1930. We never let a bill run fifteen days over two months. Within twenty-four hours we send out a notice. I haven't been in Palmerston much over a year, but in that time, in eight months, I haven't had an average of five cut-off bills to send out. Prior to the establishment of the deposit system I had from fifteen to twenty-two cut-off notices. We had two customers in Palmerston to whom you can send cut-off notices every billing period. We make a charge of $2 for disconnection and we always collect $2 from these two consumers. The others pay and as far as the deposit is concerned, they all seem satisfied if we guarantee to give them interest on their money.

Mr. P. B. Yates, St. Catharines: If this matter is going to be referred to the Standing Committee, I think it would be a great help to this committee if those of us who are interested in the subject would send a year from now, just before the next Winter Convention, our experience for the year, percentage of losses and uncollectible accounts in relation to our entire domestic revenue, and also a brief summary as to what is done to keep down these losses. In St. Catharines we are now finding that we lose very little and it doesn't pay us to chase too hard to get the small accounts that are lost. If the account is of any value at all it is easy enough to find out where this person has moved. In the great majority of cases it is collected by some other municipality for us.

Mr. McAuley: I would be glad to second Mr. Yates' request. That the Accounting and Office Administration Committee investigate and bring in a report containing recommendations towards the standardization of guarantee deposits throughout the municipalities depending upon the Hydro-Electric Power System and that this report to be available at the Summer Convention.

The motion was carried.

Co-operation Among Utilities in Collecting Final Bills

(*Discussion at Accounting and Office Administration Session of Association of Municipal Electrical Utilities Convention at Toronto, January 8, 1931.*)

Mr. A. B. Scott, Galt: I would like to say that we have had splendid co-operation from Toronto, Hamilton and two or three other places in the matter of collecting final bills from persons who have moved to these municipalities without settling their accounts. We have collected quite substantial amounts, particularly from the Toronto office and I want to express my appreciation for what they have done. I think you might adopt a policy that whenever a consumer moves from one Hydro municipality to another, he should be forced to pay the arrears that he has left in the former municipality before getting service again. We have threatened occasionally to cut off consumers, although I don't think we have ever done it, but we have succeeded in getting the money by threatening to cut the service off. We tell them the Hydro is one corporation all over. We have been able to collect some accounts through other municipalities and I want to express my appreciation to the municipalities I have named which have co-operated 100 per cent.

Mr. P. B. Yates, St. Catharines: I think it has been decided that you can't disconnect legally but we do it, and it works. If it works and doesn't get us into any legal difficulty, why not continue doing it? It is just possible that the municipality for whom you are collecing an account will have to collect one for you, and I cannot see any objection to the co-operation. We went even farther than that in St. Catharines, when we had opposition, and if our opposition cut off a consumer for non-payment of an account we wouldn't connect them up either. We cannot do it legally, but we did it and we never got into any difficulty. They can't go to court with clean hands if they start in to get you into any legal difficulty if they owe the bill.

Mr. D. B. McColl, Walkerville: I was just wondering if, while you get away with it for a time, the condition might arise where a System would cut off a consumer and the trouble might start. I would like to hear Mr. Hanna give an opinion concerning this matter. While disconnected for somebody else's account an accident might occur in the house that could be attributed to lack of service. Sometimes when these cases are brought into Court, the sympathy of the Court naturally, up to a certain point, is with the "under dog" and it has always occurred to me that there is just a possibility of their collecting damages from the local Commission. In other words, what right have we to go out and collect somebody else's account? I don't suppose it would happen once in a thousand times, because the average person doesn't like to take action against a big corporation like the Hydro, because

they fear them. I think there is another way of getting around it, that is, if the System wrote in and advised that a certain customer now living in our municipality had left their municipality owing so much money, we have always written the customer enclosing a copy of the account and advised them that the mere fact that they left the other System owing an account naturally reflected very considerably on their credit with us, and that in order to protect our interests we would have to ask them to pay the account in full, put themselves in good standing with the System they had left or pay us a guarantee deposit of $15. It would be cheaper for them to pay the other municipality. That, to my mind, leaves us in a sound position where they can't take any action.

Mr. W. G. Hanna, H.E.P.C. of Ont.: Mr. McColl seems to have approached the subject from the right angle, that is, the question of credit. A man is asking for the local Utility to give service on credit. He may have signed a contract and there may be just technical grounds for a dispute in court as to your right to claim that the contract was broken and refuse him service if you have connected up and taken the contract from him, but you are not bound to continue giving him credit when you find that he is not a good subject of credit, and it seems to me that Mr. McColl's method does suggest a more reasonable way, one that would work practically in every case without irritating the consumer too much, because it doesn't announce to all the neighbours that he left the bill unpaid. Still you might come across a tough customer who just didn't pay any attention. It seems to me that when you have demanded a deposit to make his credit good and he doesn't pay then you have the right to say, "well we are not going to supply any more credit until you make your credit good." In these questions we have the Standard Interpretations of Rates to refer to because they are made part of the contract. That Section 50, quoted this afternoon, gave you the right to use more rigorous methods. It is not perhaps as definite as it might be, but it is wide open and I think the Utility is entitled to take the steps Mr. McColl has mentioned.

In regard to the damage claim I would rather put the probabilities even greater because if an accident occurred, I do not see how any party could claim that the accident was due to the lack of electric current. They are bound to take the ordinary precautions and I don't think the Utility has much to fear in that town.

Mr. H. F. Shearer, Welland: I would like to ask in the case of a request for collection of an account from any municipality where a customer claims to have paid the outstanding account, how do you proceed?

Mr. A. B. Manson, Stratford: So far as we are concerned in Stratford, we have had a few instances of that nature. We have written to the other municipality for verification of the claim. If the claim comes back verified to the effect that the customer still owes the bill, we insist upon collection. We have collected from other municipalities outside of

Hydro. I think there should be the greatest reciprocity between the municipalities in respect to the collection of accounts.

A Delegate: Some municipalities have been known to send to other municipalities for collection of accounts running for five, six or seven months. It seems to me that if those people haven't had more backbone than to permit them to run for that long, they are not deserving of any help. In my opinion, a three months' bill is all they should send to another municipality to collect.

Mr. B. Thackeray, North York Twp.: When an account is sent out to another municipality for collection the first thing that municipality should do is to let the other one know that it has been paid if the customer should happen to settle after the request has been made to another municipality. Some time ago we cut off a consumer for another municipality. The customer came in to see me, in fact he wanted to see me at ten o'clock one night, and I went down to the office. This man behaved like a wild tiger and said "I have paid that." I said "I have no notification that you have paid it," and he pulled out a receipt showing it had been paid two or three weeks before. I didn't write to this municipality which had sent me the account. Some months after they notified me that they received the amount.

Mr. W. E. Swartz, Petrolia: If a man doesn't pay his merchandising account, we cut off his lighting connection. I have in mind the secretary of a municipality who did that. In the meantime, her friend had come home and paid the bill. The latter was referred to the legal department for advice, but it hasn't been received yet, although it happened over a year ago. I should like to ask Mr. Hanna if we are within our legal rights when we cut off a man because he owes for merchandise.

Mr. Hanna: This matter was discussed very briefly at our Summer meeting. Several of the members then expressed their opinion quite firmly that the merchandise business should be conducted on its own and merchandise sales handled as any ordinary merchant would handle them. As to the technical question, you have made two contracts with that man, one to supply him with light, and the other to sell goods to him on time. You are protected with a lien note, and you have a right to repossess and that is your remedy. There might be some difficulty if you attempted to stop supplying him current because he didn't pay on his merchandise account. As Mr. Yates has mentioned there is always the temptation, and most of the time you get away with the bluff.

Mr. Swartz: I don't believe in bluff. The reason I asked the question is that I had a considerable amount of unpaid accounts and the auditor came in and said we will cut them off. While certain auditors say you can cut them off, you can't legally do it. If the Public Utilities Commission is to be run on bluff it is wrong. We will have to be more careful where we sell our merchandise.

Mr. Bond: I do not think Mr. Swartz has had any official information from the H.E.P.C. to cut off consumers in arrears for merchandise.

Mr. Swartz: I asked for official instructions, but I didn't get them.

Mr. Bond: Did your action have the desired effect? Did you collect the account?

Mr. Swartz: Not all.

Mr. Bond: I think Mr. Hanna has covered that part very well. Mr. Swartz's method of action was suggested to him and he took it. He accomplished a certain result. If it was bluff why perhaps it was justified.

Mr. Yates: I don't suppose we have cut off a consumer to collect some other municipality's account in two years and yet we collect a lot of them. We make an honest effort to collect the account first, and the customer always has his opportunity of placing a great big deposit against his own account before he is cut off. That is always done, but I am very peeved at one or two municipalities to whom we send accounts. As soon as they receive them they say that we are told that we cannot enforce payment of this account, therefore, we cannot collect it for you. That is the opposition I have been trying for some time to overcome, and from the remarks made here to-day apparently most of the municipalities make an honest effort to collect other municipalities' accounts, and if we could all do that, I doubt if any one of us would have any trouble.

Mr. Bond: I would like to ask if any one here has ever received definite instructions from their Commission to the effect that they are not to proceed along the lines of co-operation. I believe there have been one or two cases mentioned, but I would like more information to know whether the local Commissions are behind this idea or not.

Mr. Swartz: I might answer that. We had an account sent in from Sarnia. I submitted it to the Commission. They said "collect it." That is the feeling of our Petrolia Commission. I think practically every Commission on the Hydro would feel the same way.

Mr. O. Ellwood, London: I suppose I've had as much of this co-operation with other municipalities as any other person here and like Mr. Scott, I wish to thank Hamilton and Toronto for the great assistance they have given me in this matter. We have always reciprocated to the best of our ability and in very few instances where we could locate the consumer at all have we failed to collect for them. In some instances where the amount has been considerable and the consumer in very poor circumstances, we have collected it in installments.

Mr. Bond: I feel sure that the meeting very much appreciate the remarks made by Mr. Ellwood, and I would like to call attention to two words that I think sum up the whole situation. Those two words are "courtesy" and "co-operation". I am of the opinion that if these two words were remembered most of our difficulties would fade away. We may not have the legal right to do certain things, certainly there is no law against being courteous and endeavoring to co-operate.

Mr. Scott: When Mr. Hanna answered the question raised about cutting off the consumer for arrears for merchandise, it brought to my mind the condition we have in Galt.

We operate both Water and Light. We are in the habit of cutting off the service in either department to assist in the collection of the full account. We had a case where we cut off the lighting service some time ago and the customer got along without light. Finally we went up and shut off the water, although the water account was paid in full. Apparently we could not legally do that. We are collecting the account in the meantime in any event.

Mr. Hanna: That is a new question you have raised and that is different from the merchandising question. It is perhaps just a little difficult to answer it off hand. The answer I am giving may not be entirely satisfactory, but I would like to approach that also from the angle of credit. I think if the customer who has been cuff off from electric current for failure to pay his electric light bill had been approached and told that he couldn't have credit for water extended to him until he paid a substantial deposit, you would have the right foundation upon which you could proceed.

Mr. Thackeray: I think that the question of disconnecting for another municipality in arrears comes hardest on the small municipalities. That in spite of the apparent hardship I am still of the opinion that we really should disconnect for the collection of another municipality's accounts. When all is said and done it protects you in the case of dead beats as you have some knowledge beforehand as to the consumer's ability or desire to pay his accounts and you can watch him much more carefully.

Chairman: I would just like to say that I was glad to hear the remarks of Mr. Ellwood. We have had a good deal of correspondence back and forth between London and Stratford. We happen to be one of the municipalities London has collected for. I hope that we may be able at some time to reciprocate. London, on making an inquiry in connection with one of our accounts, instead of taking drastic methods at once, simply wrote back and gave us the information in order that it might be verified. I think that is courtesy to the customer, as well as to the municipality. I would be very much disappointed should I hear of any municipality that did not extend the same courtesy to another one.

Association of Municipal Electrical Utilities

Minutes of Executive Committee Meeting.

A meeting of the Executive Committee was held at the office of the Hydro-Electric Power Commission of Ontario on the afternoon of Tuesday, April 7th, beginning at 2.00 o'clock.

The meeting was called to order by the President, Mr. J. W. Peart. Other members of the Executive Committee present were Messrs. E. J. Stapleton, C. A. Walters, H. S. Brown, C. E. Schwenger, T. W.

Brackinreid, R. S. Reynolds, T. J. Hannigan, E. V. Buchanan, R. L. Dobbin, H.T. Macdonald, O. H. Scott, J. E. B. Phelps and S. R. A. Clement.

This meeting was called for the purpose of discussing plans of the Summer Convention to be held at the Chateau Laurier, Ottawa, on June 25th, 26th and 27th, 1931.

It was moved by Mr. J. E. B. Phelps and seconded by Mr. E. J. Stapleton that the Minutes of the previous Executive Committee meeting and of the Winter Convention, as published in the HYDRO BULLETIN, be taken as read. Carried.

The names of C. L. Turnbull Company, Limited, Toronto, and Benson Wilcox Electric Company, London, were presented for commercial membership.

It was moved by Mr. R. L. Dobbin and seconded by Mr. J. E. B. Phelps that Messrs. C. L. Turnbull Company, Ltd., and Benson Wilcox Electric Company be accepted as commercial members. Carried.

The Secretary referred to correspondence with Mr. R. V. Slavin, Winnipeg Hydro, in connection with the Association extending its membership to include utilities outside the Province of Ontario and read a letter received from Mr. Slavin, advising of his inability to attend this meeting for the purpose of discussing the proposal.

Mr. E. V. Buchanan, Chairman Papers Committee, presented a report suggesting papers to be given at the Convention. His suggestions were for papers covering the following subjects:

Switching

Water Heaters.

Water Ways and Water Powers in Canada.

Merchandising.

It was also recommended that no papers should take more than fifteen to twenty minutes to read, or preferably that the paper be extracted by the author and the time given over to discussion.

Reporting on behalf of the Committee who had been appointed at the Summer Convention of 1930 to work with the Hydro Laboratories on the question of Load Unbalance, Mr. Buchanan advised that some range manufacturers are standardizing 220-volt elements or balanced load switches.

Mr. R. L. Dobbin, Chairman Committee on Accounting and Office Administration, presented a resolution by that Committee at its meeting on the morning of the same day, that the Executive be asked to provide quarters for two session on Accounting and Office Administration at the Summer Convention and also to provide a stenographer.

Mr. C. E. Schwenger, Chairman Convention Committee, presented a report from that Committee regarding proposed Convention arrangements.

It was suggested that there be a Convention session on the morning of Thursday, June 25th; a Convention luncheon on that day, followed by a short Convention session in the afternoon, and a dance in the evening—the dinner on that day not to be organized.

On Friday, June 26th, the programme to consist of the Convention session in the morning; Convention luncheon at noon, and a Convention

dinner in the evening; the afternoon being left open.

On Saturday, June 27th, it is proposed to arrange a trip up the Gatineau River.

On behalf of that Committee he asked the Executive for permission to spend $450.00 for prizes and entertainment.

It was agreed that the various committees should proceed with the Convention arrangements as outlined by their chairmen.

Mr. T. J. Hannigan consented, on behalf of the O.M.E.A., to obtain speakers for the two Convention luncheons and the Convention dinner.

Mr. R. L. Dobbin, on behalf of the Committee on Accounting and Office Administration, presented another resolution from that Committee as follows:

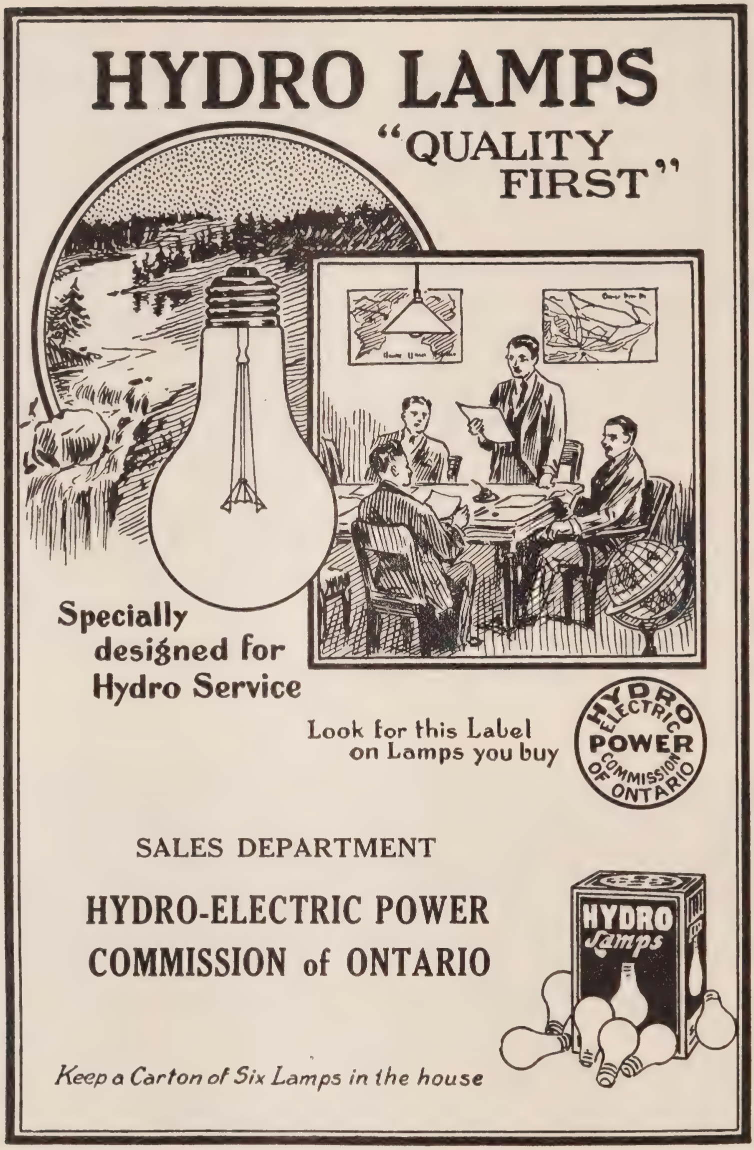
"That the Committee on Office Administration and Accounting recommend to the Executive Committee of the A.M.E.U. that provision be made in the constitution to allow of setting up divisions of the Association, such as the Office Administration and Accounting division, such divisions to have representation on the Executive of the Association and have the power to elect their own officers and subcommittees. These divisions would have full charge of the sessions of the divisions as to programmes, etc."

It was moved by Mr. C. A. Walters and seconded by Mr. O. H. Scott, that Messrs. R. L. Dobbin, R. M. Bond and I. N. Pritchard be a committee to bring in a report along the lines asked in the resolution. Carried.

Mr. H. T. Macdonald made a verbal report regarding the finances of the Association, showing them to be in a satisfactory condition.

The meeting adjourned at 4.00 o'clock.

Sarnia Hydro Shop during Christmas Season.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THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Policy of the Hydro-Electric Power Commission of Ontario Respecting Power Supplies

The Commission, on May 6th, issued a formal statement dealing specifically with some critical comments that had been made publicly respecting the general policy which the Commission has pursued in connection with its provision of power to meet the requirements of the citizens of the Province. Leading newspapers published the Commission's statement in full, accompanied by comments to the effect that the presentation dealt vigorously with the matters brought under review.

Readers of the "Bulletin" who in the past have followed, step by step, the co-operative activities of the Commission and the associated Hydro utilities, are aware of the manner in which the policies followed have for twenty years succeeded in promoting the unhampered growth of the undertaking.

In December last, the Commission's peak load was 1,286,000 horsepower. With the provision for increased power on the Gatineau, the Lievre, the St. Lawrence, the Ottawa and some other rivers, the Commission will be able to take care of an aggregate load of about 2,000,000 horsepower. The Commission's main transmission lines total about 5,000 miles. Its rural lines are being extended at the rate of 1,800 miles or more per year and now aggregate 6,700 miles in length. More than $250,000,000 is invested co-operatively in generating and transforming stations and transmission lines and equipment and about $97,000,000 is invested by the local municipal electric utilities in distribution systems and other assets. The investment in rural distribution systems is $13,000,000. The total investment in the undertaking aggregates $360,000,000.

Obviously, any official statement by the Commission relating to the program for the development of an undertaking of the magnitude of that just mentioned, is of special public interest, and, consequently, the statement is given in full as follows:

Statement of the Commission

As administrator of Ontario's "Hydro" undertaking, and therefore responsible for the provision of ample supplies of electrical power to meet the requirements of the co-operating municipalities, who are the owners and for

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May, 1931

whom the Commission acts as trustee, the Hydro-Electric Power Commission of Ontario believes that a brief formal statement made at this time will assist the citizens of the Province, individually, to a better understanding of the course of action the Commission has of late pursued, and such an understanding should remove the possibility of misapprehension arising as a result of certain misleading and unsupported statements which have recently been publicly made in criticism of the Commission's program for power supply.

Twenty-five years devoted to the creation and operation of the undertaking has, it is believed, given the Commission and its staff special experience upon which to base procedure with respect to power supplies.

Recent criticism of the Commission is along the following main lines: First, that the purchase of power from private sources is contrary to established policy and 'a departure from the principles of Sir Adam Beck'; second, that the price paid for purchased power is too high,—in support of which there are offered statements made in prospectuses of private companies; and, third, that 'secrecy' characterizes the operations of the Commission.

In considering the first point, that the purchase of power from private sources is a departure from the principles of Sir Adam Beck, it should be appreciated that throughout its history the Commission has recognized that in any comprehensive scheme for the supply of electrical energy to a large territory, the first essential is the ownership of the transmission lines and of the franchise rights for distribution. Ownership of the power plants—when possible without sacrifice of the interests of municipalities and consumers—has also been recognized as a desirable, although less essential, feature, and the Commission has consistently sought to own the developments for the sources of its power supply. The greater proportion of the supply for the Hydro municipalities comes from the thirty-five developments, including the Queenston-Chippawa plant, which have been built or acquired for the co-operating municipalities. In 1917, the Commission purchased outright the Ontario Power Company and increased its plant to 180,000 horsepower; in 1920, it acquired the Toronto Power Company's plant of over 125,000 horsepower, and in 1930 in its purchase of the Dominion Power and Transmission Company it acquired this Company's power plants aggregating 80,000 horsepower.

Now, respecting the purchase of power—a procedure which lately has been so definitely criticized: Broadly the Commission is charged with the

responsibility of providing in the best possible way for the expanding power needs of the citizens of the Province. Whether the agency for power production is to be water, coal, oil or gas, or whether power is to be purchased, is a matter which is left to the discretion of the Commission. At no time has the Commission regarded the purchase of power as being contrary or inimical to the principles upon which the Commission's program was originally based.

From the very inception of the Hydro undertaking, the Commission has not hesitated to make use of purchased power as and when found desirable in the best interests of the municipalities. The Hydro program of the great Niagara system was initiated, in 1910, by the purchase of 100,000 horsepower from the Ontario Power Company—a corporation at that time controlled from the United States—and this quantity sufficed for the first five years of the Commission's operations and until 1915 when the Commission arranged for the purchase of additional power supply from the Canadian Niagara Power Company, and later from the Toronto Power Company. Incidentally, it may be mentioned that the Ottawa system, the St. Lawrence system and the Thunder Bay system were also initiated upon the basis of power purchased from private corporations, and, moreover, purchased power has been employed in other systems in conjunction with power developed in the Commission's own generating stations.

It must be conceded, therefore, that from the initiation of the Hydro enterprise and throughout its history purchased power has been a very prominent factor in its operations, and in view of the successful achievements of the undertaking it is clear that there has been nothing detrimental to the Commission's welfare in the purchasing of power when circumstances so require.

Power Shortage Warning by Sir Adam Beck

In a public statement made by Sir Adam Beck on January 2, 1924, and speaking with reference to the people of the Province "facing a power crisis", he said:

> "We are, therefore, actually face to face with a power crisis, and within the next two or three years, drastic, if not desperate, measures must be taken in order to protect the Province against a serious stoppage in industrial activity."

Now, it is obvious that in order to meet probable demands for power for the Niagara system large sources of supply are necessary. The three main potential sources in the Province of Ontario for additional supplies of hydro-electrical energy to serve the existing systems in southern Ontario, are found on the international portion of the St. Lawrence river in which Ontario has a half interest of the 2,000,000 horsepower potentiality, on the Niagara River, where additional water could, if permission were granted, be diverted; and on the Ottawa River — an interprovincial stream—with a potentiality aggregating about 1,000,000 horsepower, of which one-half belongs to Ontario.

With regard to these possible sources of supply: The development

of the international portion of the St. Lawrence River, stretching from Lake Ontario to St. Regis, below Cornwall involves the interests of both power and navigation, and is a complex problem involving the federal governments of two countries, as well as provincial, state and other interests.

PROGRESS RE ST. LAWRENCE POWER

The St. Lawrence navigation and power problem has been the subject of investigation and effort for many years. Latterly, in 1920, the problem was referred by the two federal governments concerned to the International Joint Commission, which brought in its Report in 1922. To this organization, the Hydro-Electric Power Commission of Ontario made strong representations respecting the need of the citizens of the Province of Ontario for power to be developed from their water power in the International Section of the St. Lawrence. In 1924, the two federal governments concerned submitted the St. Lawrence problem for further investigation and report to national advisory committees and, in 1925, the governments submitted the St. Lawrence problem to a Joint Board of Engineers. The engineers submitted their first report in 1926. Since this report was submitted, additional investigations have been called for which demand still further consideration of the international and other problems involved.

In 1930, Governor Roosevelt appointed a St. Lawrence Power Development Commission to report upon the St. Lawrence problem as it affects the interests of the State of New York. This Commission reported in January, 1931, and some of its proposals are so different from others previously made that special consideration will have to be given to their significance.

These facts respecting the St. Lawrence show that the Federal Government of Canada, as well as the Federal Government of the United States, is confronted with a very difficult problem, the decisions respecting which must be of tremendous importance to Canadian welfare and development.

The Hydro-Electric Power Commission has fully appreciated the difficulties of this problem, but nevertheless has sought wherever possible to hasten by study, representation and co-operation, the development of Ontario's share of St. Lawrence power. At no time, however, has the Commission had sufficient authority to enable it to proceed with the development of Ontario's share of the St. Lawrence River power.

In connection with this development of the St. Lawrence, the evidence of engineers has been that from five to eight years would be required to complete such a development. The Hydro-Electric Power Commission believes that it could not reasonably hope, even assuming that the St. Lawrence development were commenced at once, to obtain its full share of St. Lawrence power for from seven to eight years. The St. Lawrence site, therefore, could not be counted upon as a source of immediate supply to meet the power demands with which the Commission was faced.

Power From Niagara

With respect to power from Niagara, it was concluded by governmental authorities that an additional diversion of water over and above the 56,000 cubic feet per second now provided for under the Boundary Waters Treaty of 1909-10 might, with benefit to the preservation of the scenic beauties of the Falls, be appropriated for additional power development. The matter was considered by the federal government authorities of both countries, and a proposed Treaty was drawn up. This, in 1929, was agreed to by the Dominion Government, but upon presentation to Congress at Washington was rejected by the United States Senate. For the time being, this action took away the hope that was entertained respecting the present availability of additional power supply from the Niagara River.

Ottawa River Power

With regard to the Ottawa River, where there are several large power sites, development had been held back, awaiting the settlement of certain matters concerning rights to develop power and the co-ordination of various interests and existing rights involved. Interests in the Province of Quebec which owned basic rights appertaining to half of the proposed developments had not, until recently, secured from the Quebec government the necessary authority and rights to proceed with development. Moreover, so long as the Charter of the Georgian Bay Canal Company was in existence, the Hydro-Electric Power Commission was unable to proceed in Ontario. The Georgian Bay Canal Company offered to sell power for the people of Ontario from the Company's proposed developments on the Ottawa River. The Commission, however, believed that the Federal Government of Canada would not surrender the important navigation and power privileges which the Company claimed, and moreover the Commission would not consider the proposal made to it by the representative of the Georgian Bay Canal Company to sell Ottawa River power to the Commission at a cost of $19 per horsepower per year. This Charter was terminated by Federal action in 1927.

Purchased Power the Best Solution for Needs of Immediate Future

Confronted with such circumstances as have been recited appertaining to the St. Lawrence, the Niagara and the Ottawa River powers, the Commission had no option but, in 1926 and 1927, to take other action. Comprehensive study had been made with a view to the possibility of providing electric power from steam, but it was concluded best to add to Canada's wealth by retaining in this country the money which would have to be spent abroad for coal. After exhaustive survey of all possibilities the best solution was judged to be in the purchase of 260,000 horsepower from the Gatineau Power Company, —of which 250,000 horsepower is now in use. Later, contract was entered into for an additional 60,000 to 100,000 horsepower more especially for use in eastern Ontario.

As soon as Ottawa River interests in Quebec and in Ontario had been

able to establish their rights to proceed, the Commission, in 1929, negotiated for additional Ottawa River power and, in 1930, consummated an agreement for same, entering into a co-operative arrangement for the construction of a large development at Chats Falls.

In the more immediate past also, these various considerations have been constantly under review by the Commission and, in 1929, the Commission recognized that it would have to provide immediately for still further substantial supplies of power. With the Gatineau power which had been contracted for nearly all in use and other circumstances being as just outlined, it was, after careful investigation, considered best to consummate contracts for the purchase of power from the Beauharnois development being made in Quebec on the St. Lawrence, and from the MacLaren development on the Lievre River, also in Quebec, the delivery of such power to be made, progressively in blocks, up to the fall of 1936.

The Commission is now taking 268,000 horsepower of the 791,000 horsepower it has contracted to purchase in order to assist in meeting the needs up to 1937. That is to say, one-third of the purchased provision for power has already been taken in less than one third of the time, thus leaving 525,000 horsepower to be absorbed in the next six years. This is less in amount than the output of the Queenston-Chippawa plant which commenced delivery of power in 1922 and, under conditions of market less demanding than those of the present time, the Queenston-Chippawa output was absorbed in five years.

Ownership of Plants Not Always Possible

It has already been pointed out that the purchase of power has been part of the Commission's policy from its inception, and just here it is appropriate to mention that aspect of the criticism relating to purchased power which states that the Commission is not, out of its revenue for electrical service, progressively acquiring for the municipalities, ownership in the power-producing properties, as it does in the case of its own developments. The Commission would have welcomed the opportunity to do this, but the Companies from whom the power is purchased were not willing to dispose of ownership in their properties. Moreover, the properties were existent in another Province—the Province of Quebec—where the facilities provided in the Commission's legislation for acquiring properties in Ontario required in the public interest, would not apply; and in this connection there would be just as little reason for refusing to buy power from, say, the Beauharnois Corporation, because the Commission could not acquire ownership of the plant, as there would have been for Sir Adam Beck in 1910, to refuse to contract with the Ontario Power Company for a supply of Niagara power because he could not, at that time, acquire ownership in this plant.

The Commission has always contended for the preservation of Ontario's interests in power development where it had rights and interests to conserve or to defend, and in this connection Sir Adam Beck's vigorous defence of Ontario's rights at the Carillon power site on the

Ottawa River will be recalled. Furthermore, it should not be forgotten that the municipalities' ownership of the Chats Falls power development in Ontario has been preserved.

A False Charge of Secrecy

It has been charged that the Commission conducts its operations 'with secrecy.' The Commission is about to publish its Twenty-Third Annual Report, a volume of nearly 500 pages. It has been widely conceded that no Report, whether published by public or private utilities, approaches in comprehensive presentation and detail the data presented by the Commission respecting its own operations and those of the municipal utilities. It is regretted that the contents of these Reports are not reviewed by many who undertake to speak publicly respecting the Commission's work, because if the contents of its Reports were better known, the misleading statements that are made by certain critics would probably never be uttered.

It is true that, even under pressure, the Commission has refused to disclose information respecting contracts and agreements affecting the interests of others, including those of the municipalities, where such disclosure would be injurious to all concerned. No organization, such for example, as a bank, newspaper, or large industrial concern, would publish details of business which intimately concern the welfare of its individual customers and shareholders and publication of which would be injurious.

The Price for Power Based Upon Essential Governing Factors

A word may be added respecting the criticism that has been made with regard to the price paid for purchased power. Having in mind the fact that statements have been quoted from prospectuses of private power companies, purporting to show that their contracts with the Commission are of a character specially advantageous to the companies, it is sufficient to say that the Commission is not responsible for representations made by others in prospectuses or in the public press. The price which the Commission on behalf of the municipalities was prepared to pay for its purchased power was determined upon independent investigation of facts and the knowledge of what would be a reasonable price to pay for the power, taking into account the factors which enter into the cost of its production and marketing; and in this connection it is well to remember that expenditures under private development involve costs and methods of financing quite different from those which govern under the operations of the Hydro-Electric Power Commission of Ontario. It is not possible to make proper comparisons without bringing all important technical, economic and other circumstances to a comparable basis.

Conclusion

In a word, what the Hydro-Electric Power Commission desires the citizens of Ontario to understand is that the demand for power based upon statistics of growth is from 75,000 to 100,000 horsepower per year. The

only adequate sources of hydro-electric supply in the Province to meet the needs of the great Niagara system are the St. Lawrence, the Niagara and the Ottawa Rivers. As we have seen, the St. Lawrence and Niagara possibilities have not yet become available, and the Ottawa at Chats Falls only recently became available for Ontario to proceed to develop, co-operatively, its power supply.

Consequently, in view of the governing circumstances it was absolutely necessary to ensure power supply for the municipalities from some other source.

Faced, therefore, with the necessity of providing large amounts of power either from steam or by purchase outside the Province, the Commission decided to purchase Canadian Hydro-Electric power from the sister Province of Quebec. An appreciation of all the considerations involved, and the provisions that have been made for future power supply, will show that the Commission believes that it is not in the interests of the citizens of Ontario to try, as some have done, to implant in the public mind that the Commission's operations have been secret, that it has been remiss in its dealing with circumstances, that it has failed properly to provide for the power supplies of the future, or that it has paid an unreasonable price for power.

As in the case of earlier criticisms levelled against the Nipigon, Queenston-Chippawa, and other operations of the Commission, it is believed that the future will amply demonstrate that the various actions which have more recently been taken, will be found to have been in the best interests of the citizens of the Province.

Hydro in New Hamburg

Twenty years ago, namely on February 3rd, 1911, hydro-electric power was first turned on in New Hamburg. The honour of turning on the switch which illuminated the town so brightly that evening fell to Mr. Daniel Ritz. Others present at the ceremony as far as the superintendent recollects, were Messrs. J. F. Katzenmeier, F. H. McCallum, L. Peine, D. Becker, Jacob Ernst, John Ernst, Alex. Fraser, I. M. Clemens and Wm. Buck. It will be interesting to note that of the above mentioned Mr. A. Fraser is the only one still residing there, the others having passed to the Great Beyond, or left New Hamburg.

When hydro-electric power was first inaugurated here the plant started with 72 customers. This has greatly increased since. There are 342 domestic users and 91 commercial customers, a total of 433 at the present time.

It may also be worthy of note that New Hamburg was the first municipality in the province to vote on and carry a by-law to enter into a contract for hydro-electric power.

The Alexander Power Development on the Nipigon River

By T. H. Hogg, Chief Hydraulic Engineer, H.E.P.C. of Ont.

(Paper presented before the Annual General and General Professional Meeting of the Engineering Institute of Canada at Montreal, February 4th, 5th, and 6th, 1931.)

THE Alexander hydro-electric development, on the Nipigon river, came into service in October, 1930. This development is the second constructed on this river by the Hydro-Electric Power Commission of Ontario and, like the first, supplies power to the Commission's Thunder Bay system, the principal market for power being in and near the cities of Fort William and Port Arthur, distant about 80 miles from the generating stations. The new development has a capacity of 54,000 h.p., and the original plant at Cameron Falls 75,000 h.p.

There are certain salient features of this development that warrant the preparation of a descriptive paper thereon. Among these might be mentioned: the unusual variations in design and construction necessitated by the foundation conditions and materials which varied greatly and frequently in adjacent areas; the dewatering of the dam site by a diversion channel to which the configuration of the power site readily lent itself; the method by which the closure of the diversion channel was effected on the completion of construction work; the use of the diversion channel as a power canal in the completed plant; and the provision for operation of the plant by supervisory control from the Nipigon station. In addition to these features, there are a number of other items of interest to which, along with those mentioned, more detailed attention will be given later.

Historical and Geographical

In a description of the Alexander power development, it is desirable that some geographical and historical background be given, so that the reader may better visualize the situation and grasp the significance of the various steps taken. The Thunder Bay system of the Hydro-Electric Power Commission comprises the district in and around Fort William and Port Arthur, and the village of Nipigon. The power for this system is developed by the Commission at its plants on the Nipigon river, that is to say, the Nipigon and Alexander developments, whence it is transmitted by 110,000-volt lines to the Port Arthur and Fort William transformer stations. A map of the district extending from Lake Nipigon to Fort William is shown in Fig. 1.

The Nipigon river from Lake Nipigon to Lake Superior has a total fall of approximately 250 feet, varying with the relative stages of water level in the two lakes. Of this head, the Nipigon development at Cameron Falls utilizes 78 feet, and the Alexander power development 60 feet. From the tailrace of the latter plant to the mouth of the river, a distance of 8 miles, there is a normal drop of about 4 feet, which cannot be economically utilized for the development of power. The remaining head of somewhat over 100 feet, between the headwater level of the Cameron Falls plant and Lake Nipigon, is as yet undeveloped.

In 1926 the Commission built a control dam at Virgin Falls at the outlet of Lake Nipigon, creating thereby the largest storage reservoir in existence, having a capacity of 6,700,000 acre-feet. This control dam consists of a concrete pier and stop-log structure across the main channel, and three concrete sluiceways, also stop-log controlled, in a diversion channel on the left bank. The latter channel, entirely in rock, was used to handle the discharge of the river during construction of the dam in the main channel. The sluiceways in the main and diversion channels have a combined discharge capacity of 10,000 cubic feet per second at minimum regulated lake level.

The catchment area of the Nipigon River above Virgin Falls is 9,000 square miles, of which Lake Nipigon comprises 1,700 square miles. The natural run-off in the period of record has averaged 7,600 cubic feet per second, and the storage facilities are such that the whole of this may be made available for generation of power.

The Nipigon development has an installation of six 12,500 h.p. units, of which the first two were installed in 1919, the second two in 1924, and the last two in 1926. Concurrently with the placing of the last two units in operation, the regulating dam at Virgin Falls was constructed.

General Plan of Development

The growth of load on the system and the prospective load, following the completion of the Cameron Falls plant, made it necessary for the Commission to proceed with plans for additional generating capacity. A study of the sites available indicated the advisability of choosing the site at Alexander

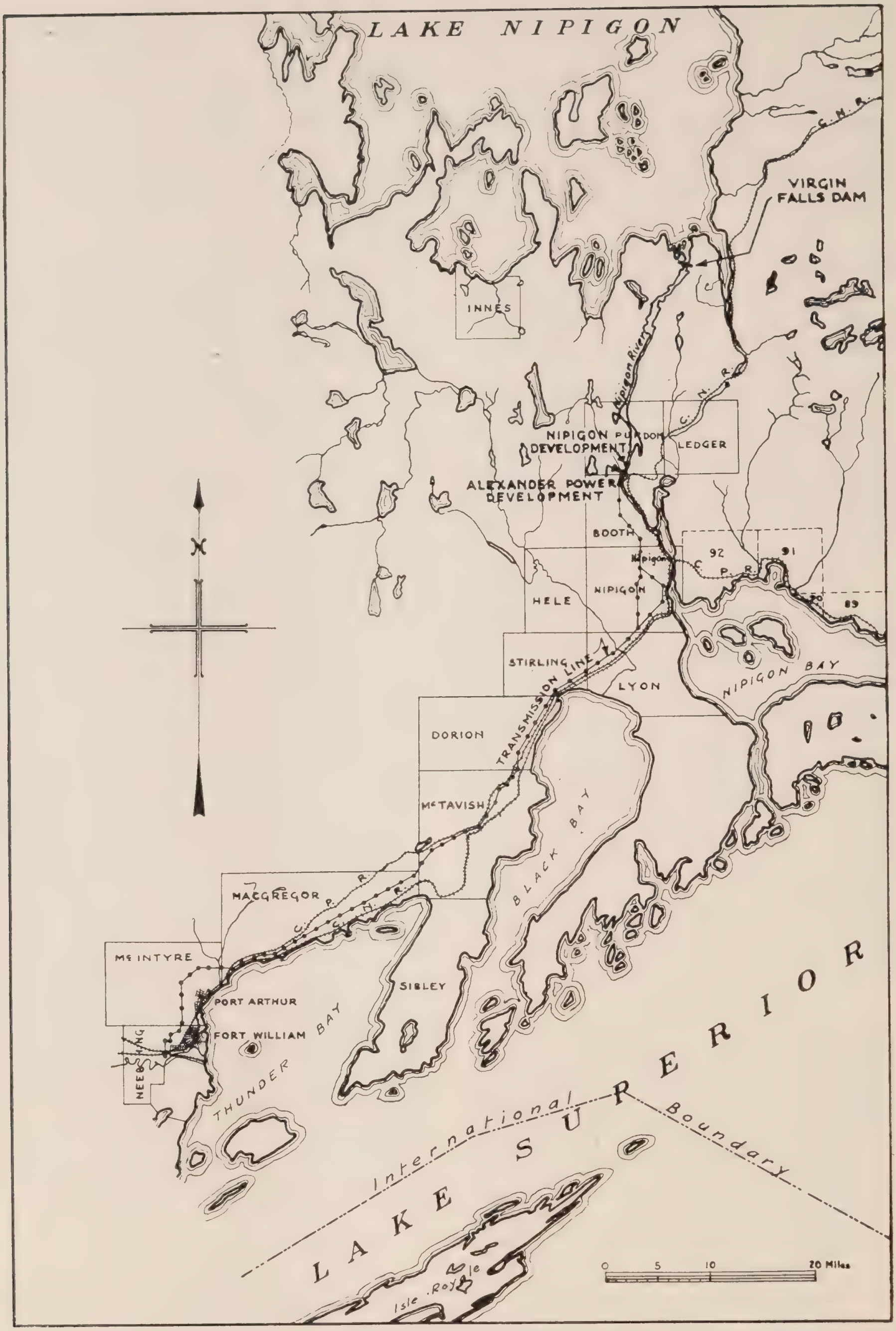


Fig. 1—Map of the District from Lake Nipigon to Fort William showing Location of Power Developments and Transmission Line

Landing, about one and one-half miles downstream from Cameron Falls. At this location a number of alternative layouts were studied, and estimates prepared, as a result of which the arrangement shown in Fig. 2 was adopted as the most suitable to the site, and at the same time the most economical.

It will be noted that at the power site, two sharp bends in the river, with the resulting backwater pools and narrow peninsulas, form an ideal location for the development of power. By damming a narrow section of the river and diverting the water through a short diversion canal across the adjoining peninsula, it was possible to isolate the two main construction operations of dam and power house with considerable attendant advantage. The diversion canal for carrying the river flow past both structures during the construction period was excavated through the peninsula near the power house. The layout also afforded an opportunity to locate the spillwall well away from the earth dam and from the entrance to the power house. Relatively low dam sections join the spillwall with the main dam and form a cut-off between the power house and the high ground to the west of the plant.

In the preliminary studies, layouts were made in which the power house and dams were located in all the feasible locations available at the site. Comparative estimates of the cost of each layout were prepared, and the most economical arrangement was selected. In considering the economics of the problem, the practical difficulties to be encountered in construction were carefully studied.

In the general plan of the development it will be seen that the main dam extends from the high ground on the east bank of the river to the peninsula upon which the spillway, power house and other structures are located. The earth fill continues for about 400 feet, with a height of only 10 feet across the level ground at the easterly extremity of this peninsula to a junction with a concrete bulkhead section which in turn joined the spillwall. From this junction the spillwall continues for about 500 feet, where it crosses the diversion canal, immediately beyond which are the log slide, fishway and power house. A short concrete bulkhead section unites the northwesterly end of the power house with the auxiliary earth dam, which, although never more than 23 feet high, is 1,800 feet long.

Service Connections to the Canadian National Railways

While the main line of the Canadian National Railways passes a short distance from the easterly end of the main dam on the opposite side of the river from the generating station, yet, in view of the existing connection from that railway to the Nipigon power house, less than a mile away, it seemed advisable to connect the Nipigon station with the Alexander station for convenience in the operation of both plants. Thus, the latter station has its service from the Canadian National Railways by way of Cameron Falls.

This involved building two standard type plate girder bridges, designed for E-40 loading plus impact; the one over the Nipigon River a short distance below Cameron Falls, and the second over Fraser Creek, a small tributary flowing through a wide deep valley not far above the Alexander development.

The location proved of material value during the construction period, in giving access to sand and gravel pits, through which the line passed, and to the old yards of the Cameron Falls development, as well as the stone quarry, near the latter plant, from which crushed stone for concrete aggregate and track ballast was obtained.

For permanent service to the new station, spurs have been built at two levels; one into the station at generator floor level, and the second at the level of headworks deck, giving access in the latter case for a locomotive crane to be used for handling head gates, racks, etc.

From the tract at the lower level, a short spur serves the transformer station, and from this point to the power house the track is supported on concrete to guard against settlement when transferring the transformers into the power house for maintenance and repair work. The upper track where it joins the headworks is carried by a short girder span from the adjacent rock outcrop to the headworks deck. The maximum grade for the lower track does not exceed 2.5 per cent. when corrected for curvature, and that for the upper line is less than 2.5 per cent. with correction.

Permanent track throughout is built of 80 and 85 pound rail, with gravel and crushed stone ballast, with the exception of that portion from transformer station to power house referred to above.

Dewatering by Means of Diversion Channel

The decision to build the main dam of earth, referred to later, necessitated the diversion of the river entirely from the dam site.

Running across the river at the location chosen for the dam, and approximately parallel to its axis, is a relatively narrow ridge of rock. Through a depression or fault in this barrier, the river has in former ages cut its way, and immediately below the dam site turns through almost 180 degrees, creating a narrow peninsula composed almost entirely of rock. This topography at once suggested an efficient method of dewatering, by diverting the river in an open channel cut across the peninsula upstream from the dam site. Here again, the natural conditions in the

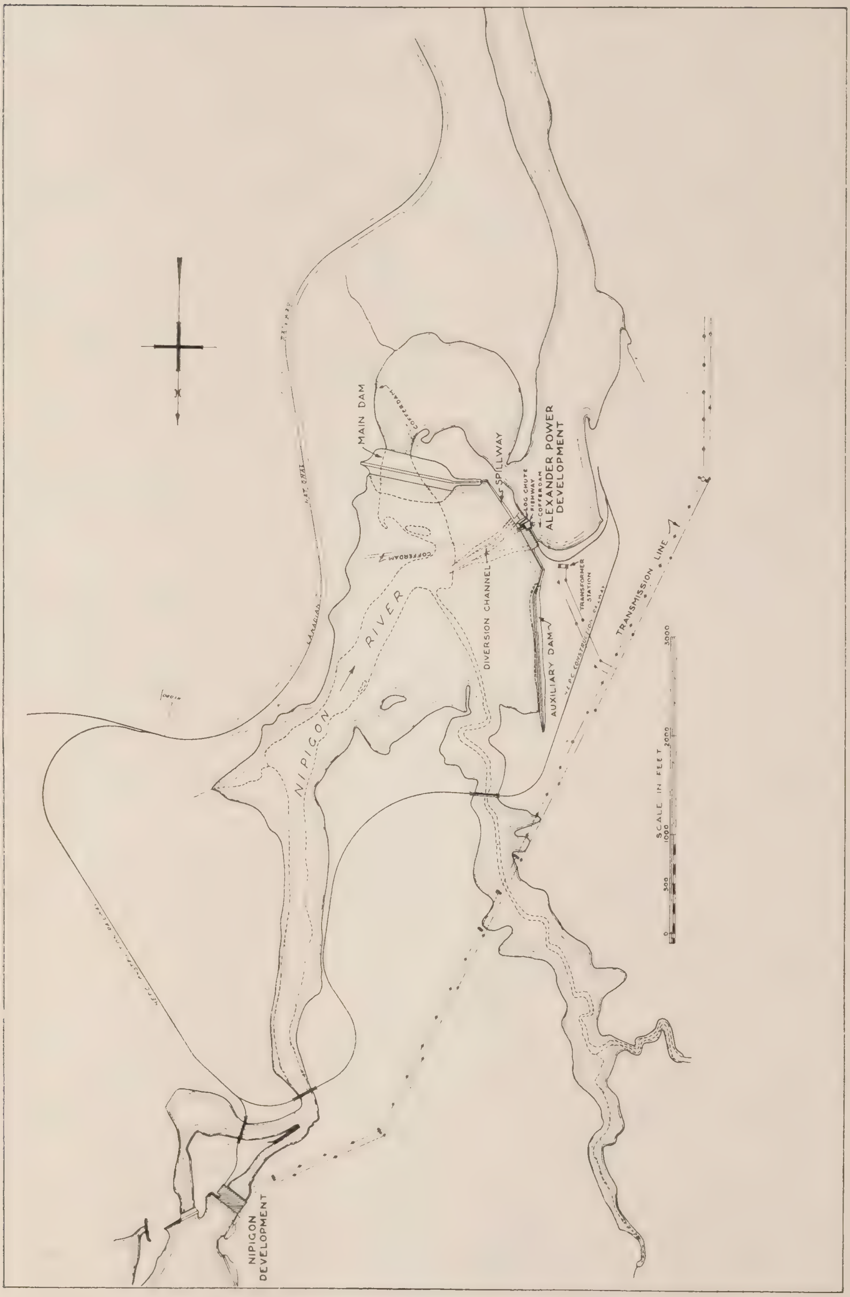


Fig. 2—Plan showing Location of Dams and Power House in relation to Nipigon Development and Transmission Line

Fig. 3—Aerial view of Development under Construction, Nipigon Power House in Background. (Photo by Royal Canadian Air Force.)

river, about 600 feet above the dam, were very favourable for a cofferdam location. A low flat point of land projects into the river, where the width of the stream is considerably reduced, creating conditions in which a large part of the cofferdam could be built on dry ground, and requiring a minimum of under-water work.

With the power house located at the downstream end of the cut across the point, the channel for diversion could be utilized for the greater part as the permanent feeder for the development. Thus the actual charges for dewatering were contained in the cost of the cofferdam and the additional depth of diversion channel, which depth was contingent on the height of the cofferdam; the economical balance in costs giving the relative heights and dimensions. The dewatering channel proper as it nears the headworks is diverted away from the feeder canal to the east, and passes through the line of the spillwall in a narrow rock cut. The closure works were located here, and the concrete for this structure ultimately formed the base for that section of the spillwall.

The discharge area actually required for diversion purposes was that necessary to provide for the water passing through the Nipigon station under full load, as the flood stages of run-off for the watershed may, with the flow required for that station, be fully conserved by the vast storage provided in Lake Nipigon by the regulating dam at Virgin Falls at the outlet to the lake. Additional discharge capacity was, however, provided for unforeseen conditions of flow.

Where the river was diverted through the spillwall, two water passages were built, each 18 feet wide and 27 feet high, giving ample area with the water at the cofferdam safely below the top to take care of any reasonable contingency in river flow. (Fig. 4.) For closure, each of these areas was provided with checks to receive steel gates in three sections, each 10 feet 4 inches high.

Main Dam

The most suitable site for the main dam was at a point on the river about one and a half miles below the Nipigon development, where the flow passed in a narrow channel flanked by rock on either side. As previously stated, the river made a pronounced bend in its course immediately below the site, creating a point or peninsula, which provides a favourable location for the diversion channel and power canal.

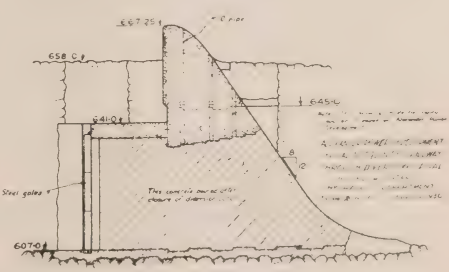


Fig. 4—Section through Sluiceways at Outlet of Diversion Channel.

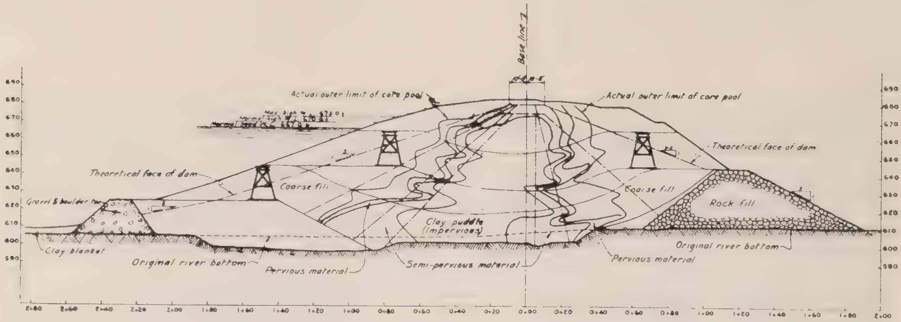


Fig. 5—Typical Section of Main Dam.

While the sides of the channel at the site of the dam are of exposed rock formation, borings made in the river bed indicated that there was no rock at economic depth for a gravity concrete bulkhead section for the greater part of the length of the dam. This condition narrowed the choice of the type of dam to one of either a reinforced concrete bulkhead or earth section. The presence of suitable and abundant materials for earth fill at elevations well above the top of the dam on the east side of the river indicated that the probable unit cost for an earth dam would be relatively less than usual, and this, with other considerations, proved the deciding factor in the choice for an earth fill dam.

A typical boring in the bed of the river at the site selected showed at the top, a layer of boulders underlain by a deep stratum of coarse sand, and thence alternate layers of boulders and sand. Soil bearing tests made at a number of points on the proposed site indicated that the bearing value of the soil was well within the margin of safe practice.

The rock walls at the shore ends of the dam were of a naturally rough formation, which, when cleared of all loose and weathered matter, revealed a vertically serrated surface providing a suitable seal for the core and abutments. These rock sides of the channel extended, the one on the east side above the high level of headwater, and the one on the west side almost to normal operating level. A typical section of the dam in Fig. 5 shows excavation for the core and that part of the base upstream from the core to be taken down deep enough to include the deposit of boulders, coarse sand and river silt; this material was used for making the upstream toe of the dam.

Before any earth fill was placed, a heavy rock dump was made forming the toe for the downstream side. This material was excavated from the rock section of the diversion channel and power house substructure. The facts that large quantities of rock had to be disposed of, and that the downstream toe of the dam proved to be quite suitable and economical as a disposal area, made it possible to provide a much more substantial support for the fill on the downstream side than it is usually economical to provide. At the same time this rock fill provides ample drainage for any seepage through the core or the foundation material underneath the core.

The section chosen had a crest width of 20 feet with downstream slopes of 2.5 to 1 and 2 to 1, and upstream slopes 3 to 1 and 5 to 1. Its maximum height as built is about 90 feet. As the base of the dam is below tailwater level, extra precautions were taken to protect the toes of the slopes. (Fig. 5.)

The section as built is much larger than designed, this being brought about largely by the necessity of keeping dump tracks safely back from the edge of the segregation pool to prevent sliding. The tendency to slide was in turn caused by the very rapid rate of placing fill. The open season for this latitude is short, and the rate of fill was therefore necessarily accelerated.

The total yardage of the dam proper, exclusive of clay blanket upstream, is about 530,000 cubic yards, and from the time the season opened in May up to the end of August there were 443,000 cubic yards placed in the dam, the rate being greatest in June, when about 159,000 cubic yards were placed. It will be of interest to note that the shrinkage in volume of material as between pit measurement and place measurement was less than 5 per cent.

The nature of the river bed upstream called for a protecting blanket of clay. This was sluiced in from materials on either side of the river to a depth ranging from 4 to 6 feet and extending upstream about 400 or 500 feet to the main cofferdam.

Construction Methods

The dam was built by the "semi-hydraulic" process, the materials being taken from selected borrow pits located on the east

side of the river. Some of the borrow pits are in gravel and sand, while others are in pure clay, so that any mix determined to be desirable could be had by regulating the amount from each of the pits.

The output of the shovels in the pits was taken to the dam by trains, and dumped from trestles on either side of the segregation pool for the core, and the fineness of the core was varied at will by controlling the placing of trainloads of selected materials at points where it was sluiced into the pool with the proper grading. The width of the core was controlled by varying the width of the pool to suit.

The excavating plant consisted of five units; one steam-driven dragline with a 3 cubic yard bucket; one railroad type steam shovel with a 2 cubic yard dipper; one full revolving steam shovel on caterpillar tread, with a 1¼ cubic yard dipper; one gasoline-driven dragline on caterpillar tread with a 1¼ cubic yard bucket; and one steam shovel on caterpillar tread with a one cubic yard dipper. They were served by eight locomotives, each with five 16 cubic yard and twenty 20 cubic yard air dump cars. The locomotives ranged from 57 tons to 30 tons in weight. There were no grades against loaded traffic, and the train-weights were limited to the brake controlling capacity of the engines, as well as by the capacity of the engines to haul empties up the relatively steep grades on the return trip from the dam to the borrow pit.

Sluicing was done by two monitors, each placed on a float in the segregation pool. Pressure was supplied by centrifugal pumps direct-connected to electric motors. Electric power was supplied by special flexible submarine cable suspended on empty oil drums. The pumps were 6-inch by 6-inch two-stage units, equipped with nickel iron impellers to resist the heavy abrasive action of water carrying a large percentage of silt. The pressure at the discharge side of the pumps was 160 pounds per square inch, and the nozzle diameter of the monitor was 2 inches. Each motor was rated at 100 h.p.

Spillwall

The spillwall, as finally located, is 523 feet between abutments, and varies in height from 1 foot to 18 feet, with an average of 7 feet. These heights do not include the depth of section where the diversion channel sluiceways are located. The crest level provides for a maximum discharge head of 6 feet and, according to Bazin's formula for flow over a sharp-crested weir, as modified for this shape and depth, the discharge capacity is 30,000 cubic feet per second. The shape of the crest approximates very closely the parabolic form. Under maximum discharge conditions, the underside of the nappe lies theoretically below the surface of the concrete, so that under no conditions of flow there will be any tendency to produce vacuum. It is not expected that under operating conditions, with the total load for the system proportionately divided between the two plants, there will be any appreciable waste over the spillwall. Only under abnormal operating conditions will there be any overflow, and the possibility of maximum discharge is most remote. With the regulation provided at Virgin Falls dam there is little or no waste at week-ends, the pondage of the lake above the Cameron Falls plant being ample to balance the fluctuations; this lake providing daily, and to some extent weekly, pondage for both plants.

In constructing the spillwall, the surface of the rock foundation was only roughened, as, with the tilted formation of the beds, ordinary blasting opens seams that would extend to indefinite depths. The natural surface of the rock was for the most part fortunately sloped upwards in the downstream direction, providing a natural resistance against sliding. Dowels were generously provided in those smaller areas where the foundation was not so favourably tilted.

The section of all gravity walls, including spillwall and bulkhead sections, was designed to give ample factors of safety against overturning, sliding and ice action.

Tie Between Earth and Concrete Sections

At the junction of concrete and earth sections for both auxiliary and main dams, specially designed abutments are built in a similar manner to that for a bridge abutment sustaining an earth fill approach. Fig. 6 shows plan, elevation and sections of these. The two wing walls at each abutment are not, however, built to conform to the outer earth slope, but are confined to the core area and are completely enveloped by the less pervious fill, which is carried 3 feet higher than the top of the concrete abutment. The sides adjacent to the core are constructed with a batter of 5:12, with the object of compensating for vertical shrinkage in the core material, and the tendency for the core to shrink away from a vertical face. The arrangement provided maintains at all times a tight contact between the earth and concrete. Five vertically placed timbers are embedded to half their depth in the faces of the abutments, to break the seepage plane between the core material and concrete, and these, together with the earth fill completely surrounding the wing walls and extending in front and behind the concrete section of dam, give reasonable assurance against destructive leakage.

The main line of the construction railway serving the mixer plant, boiler house and forebay area had of necessity to be located crossing the line of the auxiliary dam, and, in consequence, a gap through the concrete

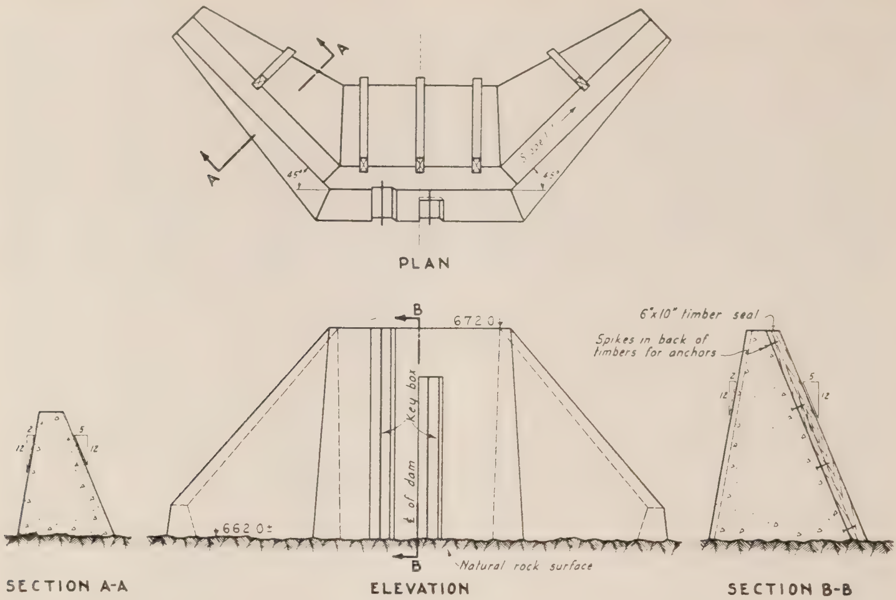


Fig. 6—Wing Walls at Junction of Concrete and Earth Fill Sections.

section was left to permit operation of trains until the last few days before the closure of the sluiceways. The concrete to close this gap was placed about a week before the closure was made, and was sufficiently set to sustain the head of water after the pool had reached its normal level.

Auxiliary Dam

The auxiliary dam, running west from the power house was made up of a concrete section tied into an earth dyke. The concrete bulkhead portion of this dam is the conventional type, having a 3-foot top width and a batter of 8:12 on the downstream side, and a maximum height of 25 feet.

The earth section of the auxiliary dam was constructed, having a central clay core supported on either side by pervious material. The central core was carried to a depth of approximately 5 feet below the base of the dam, and from this point down to impervious material or to the rock, as the case may be, a 5-foot trench was dug between timber sheeting, and back-filled with puddle clay. To date, this dam has proved to be absolutely watertight and satisfactory in every respect.

Power Canal

As previously mentioned, during the construction period the whole of the river was diverted through a channel excavated through the peninsula formed on the right bank by the course of the river. This channel, in rock, is 50 feet in width and about 33 feet deep. The course is straight for about 500 feet, and then deflected to the left through 19 degrees toward the temporary sluiceways used during construction. Downstream from the point at which the course of the diversion channel deflects, and to the right of the channel, the earth overburden was removed to form a forebay. This, and a small amount of rock excavation immediately in front of the headworks, constituted the only additional excavation required for the power canal that was not removed for the diversion channel.

To the left of the power canal, excavation was carried down over the whole of the remaining area to elevation 660, in order to assure free access of floodwater to the whole of the spillway crest, which is at elevation 667.25. To the right of the canal, the original surface is practically all submerged up to the auxiliary dam, so that, under operating conditions, there appears a large headpond having an extreme width of over half a mile, completely submerging the original channels of the Nipigon River, Fraser Creek and the diversion canal.

Headworks

Usually, in the design of headworks for a power development in a northern latitude, it has been considered necessary, and until recent years has become customary, to provide a superstructure with travelling crane for handling stop-logs, racks and headgates.

A structure of this kind adds materially to the capital cost, as well as the consequential maintenance and operating charges which are of course, reflected in the power costs. In order to eliminate as far as possible this added expense, it was decided to design the headworks without a superstructure.

However, in consequence of the extremes of low temperature and heavy snowfalls prevailing during the long winter periods, certain protective measures had to be incorporated to guard against formation of ice in the rack and gate checks and to protect the headgate hoisting mechanism.

To raise and lower headgates during normal operation, there are provided motors and hoists enclosed in a low-roofed passageway running parallel with the centre line of units, which is about 7 feet high, or sufficient to conveniently house and operate this equipment. Each unit has two gates operated by one motor through disengaging clutches on the main line shaft.

The placing and removal of stop-logs, racks and headgates is done by a locomotive crane operating on a standard gauge track on the headworks deck. The locomotive crane may be used not only for this purpose, but for innumerable other operations in connection with the two developments, including such items as loading and unloading cars in the yards, minor switching service, and the handling of miscellaneous outdoor equipment. Since, in ordinary operation, the headgates are operated by hoists provided for the purpose, any unit may be shut down in an emergency without calling on the locomotive crane, thus permitting the crane to be kept in more or less continuous use, and even at considerable distances from the generating station.

To remove a headgate for repairs or renewal it is only necessary to hoist the gate with the motor hoist to a height where it may be conveniently transferred to the locomotive crane. The width of the upper portion of the headgate checks is such that when the gate is raised for removal, it may be moved upstream, attached to the locomotive crane, and hoisted clear of the outer wall of the hoist housing. The passageway roof has hatchways, covered with removable concrete slabs made watertight with mastic joints. With these various openings available, the removal or replacement of motors and hoists is readily and conveniently effected with the locomotive crane. Removable deck beams carry the entire intake covering and crane tracks.

All openings over the stop-log and rack checks have matched plank covers made in sections fitted for quick handling; so that with the concrete curtain walls extending below low headwater level for each intake, the guide checks are well protected. In addition to this measure of protection, openings are provided immediately behind the guide checks for the headgates, through which heated air has free passage from the generator room. Provision has also been made for the installation of electric heaters, if found necessary.

For storage of the steel stop-log gate sections, two pockets are provided at the west end immediately upstream from the erection bay. These pockets are entirely below the deck level of the headworks, and are also protected with wooden hatch covers. Stop-log gate sections for one unit only are provided at the present time, but when unit No. 4 is installed, and the headgates in place for this unit, there will be released an additional set of stop-log gates, which are now serving as bulkheads in the headworks of this unit.

Racks and Stop-log Gates

The clear width of each of the two intake openings for one unit is 18 feet, and in each one there are three sections of rack panels, 11 feet 8 inches high, with bars 3 inches by 5/16 inch spaced, 5⅞ inches centre to centre. The sections are all removable, and, in order that they may be placed in proper vertical alignment, the upstream sides of each section have oak guides fastened full length to the vertical side members of the frame, which ride against the upstream side of the guide check. The total width of I-beam and oak guide is one inch less than the width of the guide check.

The top rack section for each intake opening has a horizontal baffle plate secured to the top beam of the frame and extending upstream nearly to the curtain wall to prevent floating material from passing over the top of the rack, which is below headwater level. The rack sections are designed for a differential head of 10 feet, to allow for the accumulation of ice or debris.

The racks are placed in the checks immediately ahead of the steel stop-logs, and no provision is made for cleaning them in place, except by diver, such a provision having been found unnecessary in the operation of the Cameron Falls plant.

To remove the racks, a follower is employed, with hooks near each end, which engage the top member of the rack sections through slots provided for the purpose. The follower is designed to engage or release its load by a line leading to the deck level, and is fitted with two end rollers at either end, to insure freedom from jamming in the checks.

The full depth of an opening to be closed by the stop-log gates is 47 feet, and its width is 18 feet in the clear. The gates for this purpose are in four sections, each 11 feet 9 inches deep, and are made of I-beams covered by ⅜ inch skin plates. The maximum size of I-beams in the lowest gate section is 20 inches at 65 pounds, and the closest spacing is 15 inches. The gross weight of the bottom section is about 18,000 pounds. The top three sections of the gates are adapted

for use in the tailrace stop-log checks for unwatering the draft tubes. The same follower is used for handling both stop-log gate sections and the racks.

Fishway and Log Slide

In all the developments on the Nipigon River, present and prospective fishways are essential. Lake Nipigon is a large body of clear fresh water with an established fishing industry. It also lies in a vast area well covered by pulpwood and other timber of commercial value, as a consequence of which it was necessary to provide a log slide at the Alexander plant.

In order that fish may have free passage between Lakes Nipigon and Superior by way of the Nipigon River, fishways at both the Cameron Falls and Alexander plants have been built according to the requirements of the Department of Game and Fisheries of the Province of Ontario. These are of the ladder type, with the passage-ways at the intake end spaced to suit varying levels of headwater. This type of fish ladder is very economical in the use of water, the ports supplying the flow being under a head of not more than 18 inches at any time. The velocity through these ports does not exceed 10 feet per second, as this is considered the maximum velocity against which the fish will migrate.

The pulp and paper industry in this district has already grown to considerable dimensions, and is becoming of greater importance, increasingly large quantities of pulpwood passing down the Nipigon to Lake Superior each year. To this end, the shape of the log slide at the Alexander plant is made to give the maximum log transporting capacity for the water used. The trough is "V" shaped and constructed of timber supported on concrete piers and timber cribs, heavy cribbing having been used at the lower end as protection against ice action.

Hydraulic Equipment

The hydraulic equipment consists of three vertical shaft Francis turbines, placed in reinforced concrete scroll casings. Each is rated at 18,000 h.p. at 100 r.p.m. under a normal operating head of 60 feet. The turbines were manufactured by the S.

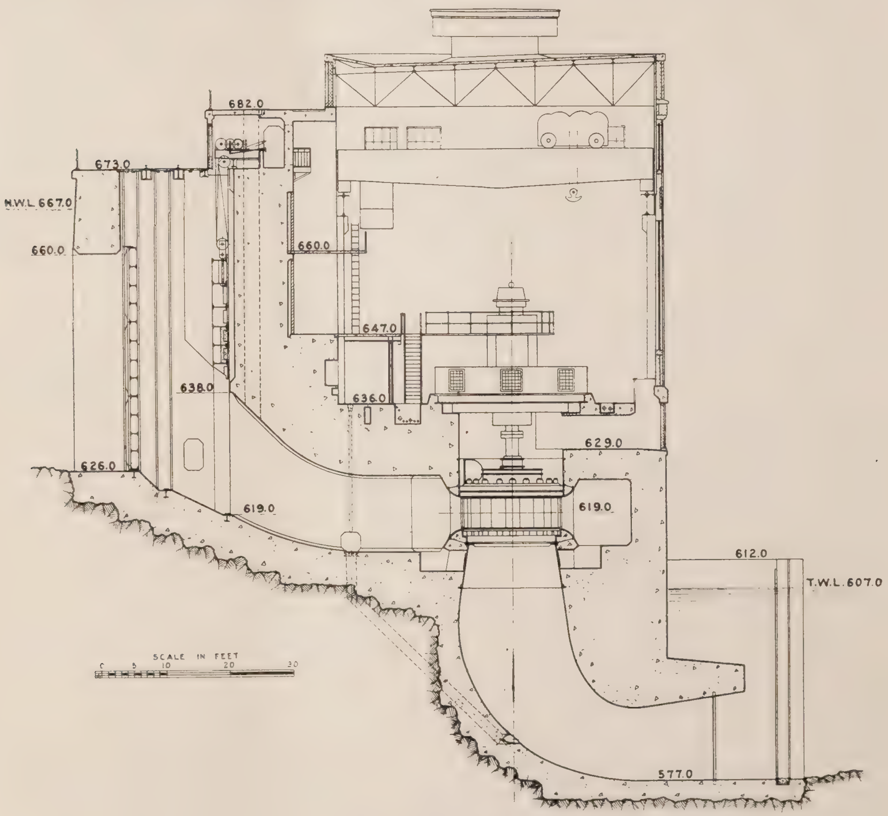


Fig. 7—Section through Power House.

Fig 8—General view of Forebay and Power House Headworks, Diversion Channel in left Foreground.

Morgan Smith-Inglis Company, Ltd., of Toronto. The oil pressure governors and oil pumping equipment were furnished by the Woodward Company of Rockford, Ill., through the turbine contractor. This equipment was placed on order in the year 1927, and, while at that time a number of propeller turbines were in operation under 60-foot head (which, if employed in this case would have reduced equipment cost,) the general performance at that time was such that the Commission's engineers did not think it advisable to select propeller turbines for this development. The Francis turbine of moderate specific speed was given preference, and in view of the fact that acceptable part-gate efficiency was anticipated by all competing manufacturers, it was decided to install the above described units.

Furthermore, in view of the fact that improved elbow draft tubes were simple in construction, and as such types showed equally good results compared with other types, decision was given in favour of the elbow draft tubes.

The casings and intake conduits are of reinforced concrete and conventional type and construction, needing no further comment.

The successful bidder of the water wheel contract preferred to furnish the solid type speed ring. This type differs from present-day practice, inasmuch as the stay vanes are integrally cast with upper and lower stay rings. This construction provided a rather simple method of taking care of hydrostatic pressures in the turbine casing, a simple and effective method of connecting reinforcing rods into the stay rings being incorporated in the casing.

In general, the turbine consists of a cast iron runner wheel weighing about 95,000 pounds, with fifteen blades cast integrally between hub and crown. It is fastened to the shaft by means of tapered fit and retaining ring. A set of twenty cast steel gates are

Fig. 9—View of Power House from Downstream Side, all river flow passing over Spillway.

Fig. 10—View looking along Main Dam toward Power House.

installed to regulate the flow of water. These gates are cast integrally with the gate stems, which are connected by links and pins to the cast steel regulating ring. This ring, in turn, is connected through adjustable rods to the two servomotors, which are operated through oil pressure. The link connection is of the tension-shearing type, providing protection against distortion of the gate shaft or breaking of gate arms in case of foreign material lodging between the gates.

In order to enable regular inspection of the turbine runner and to repair damaged blades, access is provided through pits and inspection covers placed in the upper draft tube, which is lined with steel plate.

The coupling between the turbine and generator is forged integrally with the shaft. The main guide bearing is of the adjustable water lubricated type, and is bolted direct to the turbine head cover.

(*Continued in June number.*)

What Price Whoopee at Conventions?

Recently at a conference of the township road superintendents of Western Ontario, a well-known engineer expressed his disapproval of the "whoopee-making" that, he declared, characterized certain conventions in Toronto. Liquor and lavish entertainment were provided for delegates, he said, for which he placed responsibility on the representatives of manufactures and supply houses. "Salesmen who adopt such tactics to win the favor of convention delegates should be put out of business," he contended, "and unless this form of entertainment is stopped it is time the annual conventions be abandoned."

It is no secret, of course, that "whoopee-making", as this engineer designates it, is an interesting part of many technical conventions, but it is extremely doubtful if it has any great business influence. We hope not. Observation of a large number of conventions has led us to the belief that the men with large orders to place are not generally those who are amenable to this type of argument, or that the salesmen whose expense accounts do not provide for this form of entertainment fail to receive their full share of the business that is going. Nevertheless, there are doubtless many who will agree with the suggestion and urge the suppression of "whoopee" on the grounds that it interferes with the serious business of the convention—just as much as golf does when delegates absent themselves from the technical sessions so that they may enjoy a "round" in comfort.

While we make no suggestion for prohibition of any form of wholesale entertainment or amusement, we do feel that there is a time for everything and that it would represent a comparatively small loss to the industry if "whoopee-makers", who take no interest in the convention programme proper, should find business at home so pressing that they could not leave it.

Of course this does not apply to electrical conventions, but we thought that we would record it as a matter of academic interest.—*Electrical News and Engineering.*

WHY METER READERS GET GRAY

Not long ago a woman called the local utility company to say that the new electric meter installed in her home a few days previous registered well over a million. The inspector hurried out, having visions of finding kilowatts running about all over the place. When the inspector arrived the lady conducted him to the meter and pointed to the serial number on the name plate. Our informant does not tell what the inspector said—or thought.—*The Electric Journal.*

Fifty years ago, according to *The Electrician* of March 19, 1881, Mr. Chew, in the course of his inaugural address as president of the Manchester District Institution of Gas Engineers, stated that he was quite convinced that electric light would not supersede gas for domestic illumination, though it was well adapted for large spaces, and even here he thought that when the novelty had worn off gas would hold its own. He was far more afraid of American oil at one shilling a gallon than of Mr. Swan's or any other lamp.—*The Electrician.*

SEE THE CAPITOL CITY OF CANADA

and

CHATS FALLS POWER DEVELOPMENT

O.M.E.A. and A.M.E.U. CONVENTION

at

Chateau Laurier, Ottawa

JUNE 25, 26 and 27, 1931

The Chain Gang

The rather ominous and equivocal reference in the title was suggested by one of the group shown herewith while the men were assembling. The men in charge of survey parties of the Commission were recently called into the office for instructions and it was on this occasion the picture was made. From left to right the names are C. G. Millard, F. L. Davis, C. C. Martin, R. A. Lawther, A. E. Davison, C. R. Clark, I. F. Willsie, J. Grant, H. R. Holland, M. J. Tulley, G. H. Bryson and J. A. G. White.

The survey work of the Commission has reached considerable proportions. The extent of this work may be judged by the surveys carried out during 1930. The staking of wood pole lines alone during the past year is equivalent to a continuous line from Lake Superior ports to the waters of the Pacific at Vancouver, B.C. The transmission line surveys are equivalent to a line from the Bay of Fundy ports such as St. John, N.B. to Lake Superior, making a complete trans-continental line surveyed during the year. In carrying out this work, air photographs were secured and air maps assembled so as to assist this ground survey work and correlate it with neighbouring territory to the extent of well over 1,000 miles.

Radio Interference

I.

The "Noisy Noise" in Radio

WHEN tongue-twisting sentences were somewhat popular a few years ago, there was one which ran about as follows,—"What noise annoys an oyster?"—with the rather meaningless answer,—"A noisy noise annoys an oyster."

The troubles of a bivalve may not arouse much general interest, but at the present time if the oyster be replaced by the broadcast listener in the shell seclusion of his own home, then a very real and very annoying "noisy noise" is that of radio interference,—those persistent and unwanted sounds which at times seem inherent in radio reception.

Radio interference is not a matter of the wave form of radiation reaching the antenna but rather of the audio wave form produced by the receiver from such radiations. At any instant waves from many broadcasting stations may be coming to the antenna, though only the one of proper frequency will effectively excite the radio frequency circuits and produce audible sounds from the loud speaker, so in that way resonance in the circuits is the means of preventing interference from the many stations operating at the same time. Other radiations may produce "audio" frequencies beyond the range of operation of the loud speaker and thus not be allowed to interfere with reception.

Sounds may be divided arbitrarily into two groups,—music and noise,—the former including both simple and complex periodic vibrations while the latter includes non-periodic waves. Radio interference may be of either kind, but if of the former, it will probably be due to the heterodyning of two transmitting stations, a condition which would likely be very promptly remedied by re-allocation of wave length of either station. Most serious radio interference, however, is of the latter type,—annoying noise,—such as hissing, scratching, frying, shocks, knocks or roar.

The human voice uses both groups of sounds in that the vowels, and some consonants, are produced by periodic vibrations whereas other consonants are produced by distinctly non-periodic wave forms.

The wave form of interference current to the loud speaker may then be of practically the same shape as that of certain consonants. It is interference, however, not so much by virtue of this wave form as due to its persistence when not wanted. For example, the pronunciation of the word "Toronto" may be part of a broadcast and, as such, would not be considered interference: it includes two t's, however, and if such a consonant were persistently repeated from a loud speaker,—as "tut-ut-ut-ut-ut—", just as may be caused by some electrical device,—this would most surely be a type of interference.

Considering then that the real "noisy noises" are eventually of

much the same wave form as the sounds which it is desired to hear, how would it be possible to make the desired separation? It may not be possible in the receivers at present: some later day may see the solution, but about all that may be done with any promise of success just now is to trace the interference to its source, and remove the cause.

The problem of building an instrument capable of receiving broadcast transmissions and excluding all interference would be similar to that of constructing a pail that would hold milk but would not hold water: the two conditions are so much alike that it is difficult to draw a line between them. Nevertheless, by changes in the receiver it may be possible to alleviate the trouble to some degree.

(*a*) If the interference be of high pitch, or of low pitch, the amplifying transformers and loud speaker may be replaced by others which are not so efficient at the interfering audio frequencies.

(*b*) If the antenna be near a power line and the receiver be of such design as to isolate the antenna from ground, a suitable drain coil bridged across from lead-in wire to ground connection, would by-pass currents caused by electrostatic induction at operating frequency, and thus may save the situation.

(*c*) A change in position of aerial, or a different ground connection, may lessen the amount of interference.

The removal of the cause of interference, however, usually remains the only certain cure for the trouble. To locate the source may be very difficult as the interference may be carried by circuits on which it does not originate and which would mislead rather than aid the searcher.

When the cause is found it may be a characteristic of some appliance or machine, in which case a suitable filter, consisting of inductance coils and fixed condensers, should prevent the interference from being carried out by the circuits which supply the power to the device. Where the cause is found to be some defect in the power circuit, this is usually remedied promptly by the power company in their own interests of reliability of service, as well as their desire to improve broadcast reception conditions for their customers.

But the "noisy noise" of radio interference may still persist, for it may be due to "atmospherics",—static electrical effects in nature. In this case, the source is beyond human reach and control and it is not, then, possible to prevent the radiations. An improvement in conditions may be effected, however, by the use of a short indoor antenna coupled with a limited desire for distance on the part of the listener while the interference from this cause remains serious. The use of a loud speaker having a high natural pitch, in preference to one having a low natural frequency may render interference from static less troublesome but may spoil the quality of tone.

It is, then, the persistence of the interfering wave, rather than its wave form, which constitutes the annoyance; the changes in receiver design may be relied upon, only to a limited extent, to suppress radio

interference; and it still remains necessary to silence the "noisy noise" at its source. The problem then is to find the source. —*F.K.D.*

A Small Load Circuit Breaker

THERE is now obtainable a small circuit breaker which is intended for use on domestic circuits. It has been developed more particularly to replace the fuses now used in household wiring installations, as well as other lighting, small power and branch circuits.

The fuse, the first device adopted for protection against short circuits and overloads, has been retained up to the present for this particular use, since it has been the only device which could be considered reasonably reliable. We must admit there have been wonderful improvements in the methods of its installation, in the way of protection and removal of possible danger, yet in some of its forms it is far from tamper proof.

So long as a fuse is not required to function it may be considered satisfactory, but from the moment it is called upon to do its duty there is, at least, inconvenience. The question of fuse replacement is of considerable import to all electrical utilities. Whether or not there should be a charge for servicing fuses has been much debated, but never satisfactorily answered. Then, there is the inconvenience to the user, due to an interruption of his power supply, sometimes at a time when most needed. In all electric utilities, fuse replacement is considered emergency service, some retaining a trouble department which is on duty twenty-four hours a day chiefly for that purpose.

In rural districts the inconvenience due to blowing of fuses may at times become really serious. This is realized when one considers the area served by one system and the distances a trouble man might be required to go under travelling conditions rarely met with within towns. Here at least circuit breakers are really needed.

Consideration of such inconveniences, and the continual addition of appliance load to domestic service has for some time directed thought toward the development of a circuit breaker suitable for domestic use, and it now appears as if the problem has been satisfactorily answered.

Circuit breakers for use where fuses were heretofore required on lighting circuits have been placed on the market in 15, 20, 25, 35 or 50 ampere capacities for use on 125-volt two-wire or 250-volt three-wire single-phase circuits. They are made for mounting in a small wall cabinet with cover, the size varying with the number of breakers it is desired to install at that location. The completed installation has the appearance of being a number of tumbler switches with a cover plate about fourteen inches high. The breaker is opened or closed in the same manner as a tumbler switch and when tripped by overload or short-circuit the handle assumes a middle position indicating

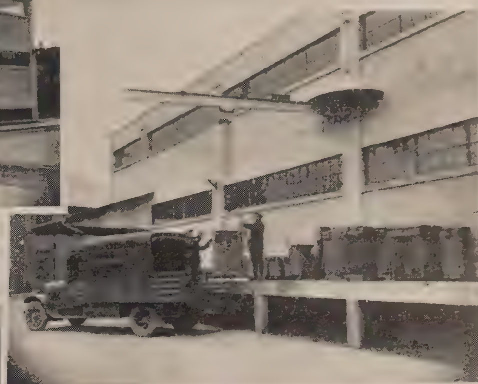
that fact. It is impossible to hold the breaker closed in event of an overload, the trip being free from the handle. The construction is such that its capacity cannot be changed, the tripping being accomplished by a bi-metal strip through which the full load of the circuit controlled must pass, and the cover is sealed to the base in the factory to prevent tampering with the mechanism. In event of the circuit breaker failing to open on a short circuit or heavy overload, the bi-metal link will function in the same manner as a fuse and prevent the destruction of the other parts of the device.

It is claimed that the device is an entirely satisfactory inverse-time-element overload circuit breaker, capable of repeatedly opening short-circuits. It will carry 100 per cent. of rated current continuously but will open eventually on 125 per cent. of rated current. On 200 per cent. current it will open in one minute. Claims regarding the breaker withstanding opening and closing under different conditions are also encouraging.

The suggestion of the makers is that groups of these circuit breakers be used instead of branch fuses, but there are, no doubt, a number of other applications where it would be desirable. The one indicated in the foregoing is to replace service fuses as now required and we are led to believe that a service box to house the meter and a two-wire breaker and suitable for outdoor mounting, if necessary, will soon be available. With the installation of a circuit breaker of this type replacing the service fuse and also its use for the protection of branch circuits, the duties of the trouble man will be greatly reduced. Should a consumer thoughtlessly overload one of his circuits or his service and thereby interrupt the supply, it will be but a small matter for him to restore service while at the same time he has been warned that he must reduce his load. The complete control of the load would be placed in the hands of the consumer, giving him ample protection and reducing inconvenience to a minimum.

Kitchener P.U.C. Warehouse

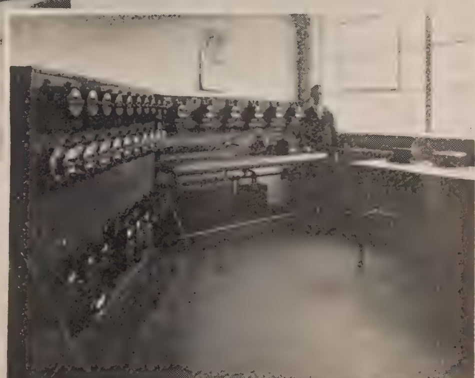
No. 1. Warehouse Building



No. 2. Loading Platform

No. 3. A Section in Stock Room

No. 4. A Section in Electrical Meter Room →



The accompanying illustrations are of the new warehouse of Kitchener Public Utilities Commission. It is a combination warehouse, erected for the storing of all gas and electric supplies. The building is 60 ft. by 80 ft. and is constructed entirely of reinforced concrete with brick panels; provision being made for additional stories as required. Photograph No. 1 shows location of truck and elevator entrance. No. 2 shows the transformer platform at the rear of the building with overhead swinging crane. No. 3 shows a section of the shelving for the storing of electrical supplies. No. 4 is a photograph of a section of the electric meter testing room showing test board and truck for handling meters.

A Novel View of Electrical Brooders

A worthy lieutenant-colonel, writing to a leading poultry magazine recently, has made an interesting discovery relating to electricity. Used discreetly by the earnest propagandist, this discovery should be a load builder.

Rearers of chickens experience every year more or less trouble from cannibalism. Chicks of the tenderest age, in circumstances which are still obscure, will peck each other to death, and outbreaks of cannibalism may occur quite suddenly at any stage of the period of rapid growth.

The introduction of "battery brooders," that is to say, aggregations of heated cages in which thousands of chickens are reared through the first few weeks of life, has been thought by some to have increased the incidence of cannibalism. As a rule, these brooders have been heated by means of coal- or oil-fired boilers through a system of hot water pipes, but our gallant colonel heated his battery brooders electrically and has no doubt at all that his freedom from cannibalism is connected intimately with that fact. He is one of your thoroughly practical men with no scientific nonsense about him. No one in his senses, says he, would attempt to explain the magnetic compass solely in terms of the magnetic needle, yet that is what science (sic) is trying to do with regard to most poultry problems. "As everyone knows, one can test whether a torch battery is charged by licking the leads and seeing if there is a salt taste. What I believe is, that electrical heat is fundamentally a dead mineral heat with a sort of saltness about it (at least where the heating element is not enclosed in glass) that satisfies the birds and removes the desire for salt that is normally expressed in cannibalism . . . . My observations and experiments have led me to believe that there are differences in heat according to how it is originated, which are not suspected at present by orthodox science."

This profound thinker desires more attention to be paid to possible terrestrial influences. "One very obvious difference, for instance, between England and America is the magnetic variation. Nobody seems to have considered the possibility that this variation may cause a subtle difference in life in these two countries, so that scientific experiments in America on, say, vitamins, may not necessarily be true for the British Isles."

It would be a pity to comment upon the foregoing, but it would make a good text for a lecture upon the muddled working of the unscientifically trained mind.—*The Electrical Review*.

Order

The affairs of a man of order move like a procession of habituated marchers, while those of the man who is careless, inconstant and unstable move like the surging of an undisciplined crowd.

The man of orderly habits looses no time in shuffling things about to find what to do next. He simply falls into step with his day's work.

He moves in his accustomed way and things move along with him.

He has the tools and materials, the records and references for the task of the hour ready to hand. He would have the job done while one of less orderly habits would be deciding what to tackle next and getting its essentials together.

His personnel and associates know how to serve and to work with him to advantage. Their work is laid out and timed to correlate with his own. They know what to do and when and how to do it.

No man's work and no man's life, however well regulated, flows with unbroken streamlines. Emergencies will arise, interruptions will occur and accidents will happen.

The man of orderly habits is not swept off his feet by such incursions. Their resolution is a part of the day's work. And just as it is easier to restore order and re-establish progress with a drilled crew or a disciplined regiment, so it is easier for him to straighten out the confusion, decide upon the best solution of the difficulty and put the necessary measures into effect.

Order is simply a manifestation of organization, of habitual system, of accustomed readiness, of wonted attention to detail, of punctual pains to keep things as they ought to be.

Order becomes a habit and extends to mental as well as to physical processes. The man who has acquired it will do more in less time, neglect and overlook less, be more dependable, be a better workman and a more efficient executive and sail a straighter and smoother course than the perhaps more brilliant man to whom order is irksome and regularity a restraint.

F. R. Low, in *Power*.

The Electrician of December 4, 1880, reported that in order to light the town of Ogden, Utah (the first town west of the Mississippi to adopt the electric light), four lamps of 3,000 candle-power each were to be suspended from a flagstaff 60 feet high, mounted on the dome of the courthouse, giving a total elevation of 200 feet. The lamps so placed were "guaranteed to illuminate abundantly a space one mile in diameter."—*The Electrician.*

Hydro News Items

Eastern System

The municipality of Trenton is considering the submission of a vote to the electors with regard to the purchase of their local distribution system and the purchase of power from the Commission on a cost basis.

* * * *

The municipality of Deseronto having purchased its distribution system will take over operation of the local Utility as from April 1st.

* * * *

The municipality of Tweed having purchased its distribution system will take over operation of the local Utility as from May 1st.

* * * *

The village of Hastings has now completed a cost contract with this Commission. The existing distribution system has been completely rebuilt by the Commission on behalf of the municipality.

* * * *

The village of Bobcaygeon, which generates its own power, finds that the increasing load is beyond the capacity of the local plant and is considering a supply of power from this Commission.

* * * *

Georgian Bay System

Arrangements have been completed for the permanent connection to the Georgian Bay System, of the various distribution systems in the Bruce County towns, acquired by the Commission with the purchase of the Public Utilities Consolidated properties, formerly under Foshay management. New 22 kv. transmission lines are being constructed from Southampton to Port Elgin and from a point near Tara to Wiarton, and the 4 kv. L.T. line between Chesley and Paisley is also being converted to 22 kv. New substations are to be constructed at Wiarton, Port Elgin and Paisley, and from the latter service will be given to the rural district between Walkerton and Port Elgin, including the hamlets of Pinkerton, Chepstow and Cargill. Arrangements are also being made for the reconstruction of the distribution systems in Wiarton, Port Elgin, Walkerton and Southampton, and it is expected that all of this work will be completed and the various equipment in operation before the end of the coming summer.

* * * *

A rural line approximately 12 miles in length is now under construction north and west of the Town of Huntsville to serve the district lying between the latte and Dwight, in the Townships of Chaffey and Franklin. The electrical energy for this line will be obtained from the Huntsville substation by utilizing a part of the Huntsville Distribution System. It is expected that this line will be placed in service on or about July 1st next.

A new L.T. line is now under construction between Windermere and Rosseau in the Muskoka district for the purpose of serving the Village of Rosseau, and the adjacent district. The electrical energy will be obtained out of the Utterson sub-station over the existing line between that point and Windermere. It is expected that this line will be in operation and service available on or about July 1st

* * * *

Niagara System

Up to the present time the Municipalities situated between the City of Toronto and Lake Simcoe have been served by a 13,200-volt line. The total distance is approximately 54 miles, and the total load taken by these Municipalities has at times been close to 8,000 horsepower.

In order to give adequate service to the district, arrangements have been made to change the transmission voltage for the district to 26,400 volts, the old 13,200-volt line being largely rebuilt. Power is being obtained from the high tension station at Leaside at 13,200 volts and 2-5,000 kv-a. three-phase auto transformers are being installed at Willowdale on north Yonge Street in order to obtain a 26,400-volt supply for the time being. It is proposed when the loads increase sufficiently that this district shall be taken care of by a 110,000-volt station to be constructed near Newmarket. It is expected, however, that the present arrangement will be satisfactory for a period of at least 5 years. The work of changing over to 26,000 volts will be practically completed by the end of May.

* * * *

Last Winter the employees of Chatham Hydro, through contribution of a small portion of their salaries each month, maintained a fund to assist needy of that city. This fund has recently been closed and shows that during the Winter a total of $209.00 was contributed and spent for charitable purposes.

During that time forty-one people of Chatham were given assistance, through the purchase and donation of many articles including food and clothing.

* * * *

Strathroy Public Utilities Commission are changing their distribution station by the installation of three 500 kv-a., 26.4-13.2/4 kv., outdoor, O.I.S.C. transformers; 26.4 kv., outdoor, oil circuit breaker, and 26.4-13.2 kv. station oxide lightning arresters. The 4 kv. station feeders are also being overhauled. When this work is completed Strathroy Public Utilities Commission will be in a position to receive 26.4 kv. power from the Commission at such time as it may be decided to transmit at the higher voltage.

* * * *

The capacity of Essex Distributing Station has been increased by the installation of three 300 kv-a., 26.4/4 kv. transformers. These replace three 150 kv-a. formerly used in this station which serve the Town of Essex and surrounding rural district.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of Ontario

190 University Avenue
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Subscription Price $2.00
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Hydro's New Chairman

The Honorable John Robert Cooke

IN his public announcement on June 8th of the appointment of Hon. John Robert Cooke as permanent Chairman of the Hydro-Electric Power Commission of Ontario, Premier George S. Henry stated:

"Mr. Cooke's long experience with Hydro, which began some eleven years ago, when he was appointed by the Legislature on the committee that studied the distribution of current to the rural parts of the Province, and his eight years' service as a member of the Commission under the late Sir Adam Beck, and, latterly, Mr. C. A. Magrath, peculiarly fit him for this important post. The Government feels that this appointment will meet with general commendation throughout the Province."

Hon. J. R. Cooke

Comments in the daily press upon the appointment of Mr. Cooke, who had been acting Chairman since the retirement of Mr. C. A. Magrath, clearly indicate that the Government's action has met with the anticipated commendation.

The possession of an extensive personal experience with the various operations of the Hydro organization and the careful consideration he has for so long given to Hydro matters, will contribute substantially to Mr. Cooke's ability to exercise sane judgment respecting

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the many difficult problems which are constantly before the Commission. None are better able to appreciate this than are those upon the staff of the Commission who have been identified with the undertaking for many years. To these, particularly, it is a matter of gratification to know that in his new office Mr. Cooke will be afforded an enlarged opportunity to manifest the painstaking and competent interest he has shown in the co-operative, electrical enterprise of Ontario municipalities—and, indeed, in general public affairs affecting the welfare of his native Province.

John Robert Cooke was born at Harold, Ontario (Hastings County) on September 1, 1864, where his parents—both pioneer settlers from Ireland—had decided to make their new home. Mr. Cooke is the son of James and Margaret (Duggan) Cooke who emigrated to Canada about 1850 and took up farming. In September, 1888, Mr. Cooke married Emma Wickens, the daughter of William and Mary Wickens of Ivanhoe. Mr. Cooke is very retiring with respect to personal matters, but when occasion has offered, it has been a great pleasure for him to pay homage to the constant encouragement and assistance, in both his private and public work, that he has received from his wife.

Mr. Cooke in his early years had the fine advantages which the public schools of Ontario afford, but his education did not stop with the termination of school work. Mr. Cooke is an earnest student and has sought by careful reading and contacts to improve and broaden his outlook upon social and other public problems.

Endowed with broad human sympathies, Mr. Cooke has welcomed opportunity to serve his fellow-citizens. In 1900, he was elected Councillor in Rawdon Township, Hastings County, a position which he held until 1908 when he became Deputy Reeve. In 1910, he was honoured by being made Reeve. The following year Mr. Cooke was elected by acclamation to the Ontario Legislature for North Hastings; he was re-elected in 1914; again in 1919 (by acclamation); and again in 1923 and in 1926. In 1929, he was re-elected without opposition, it being widely conceded by both political parties that Mr. Cooke was the best Provincial representative they could appoint for their electoral district.

Mr. Cooke's wide interest in public affairs, his sober judgment and caution in not expressing his views without careful consideration, commended him in the Legislature, and so on July 16, 1923, he was appointed Minister without Portfolio, and in the same month, was appointed a Member of the Hydro-Electric Power Commission of Ontario, a position which he has continuously held.

Upon Mr. Magrath's retirement, Mr. Cooke became Acting Chairman, and in June 1931 was officially appointed to the Chairmanship of the Commission.

Mr. Cooke's personal experience with his parents upon their farm, and later in connection with farming on his own account, has given him an intimate knowledge of the difficulties and advantages of agricultural activity in Ontario. This accounts for the fact that no one has been more zealous than he to advance the work of the Commission in the field of rural electrification, and for the further fact that some of the special measures on the Statute book of the Province reflect his experience, as well as his intelligent understanding of the electrical needs of the agriculturalist and rural dweller.

It is not alone in the field of rural electrification that Mr. Cooke is expert. He has also been a diligent student in the matter of advancing elementary education. He early appreciated the fact that a good and intelligent citizenship could not be built up without bestowing special care upon the education of the youth of the country. He believes that State compulsion—in the harsher interpretation of that term—is detrimental to true educational progress and that it is much better to induce interest by offering to the citizens superior educational advantages, the State aiding, where necessary, by legislative grant. Mr. Cooke, in legislative and other discussion, has contended that the best possible educational advantages should extend even to the scattered and less favored districts, and that in rendering such service, proper account should be taken of the ability—or inability—of the rural citizens to pay the full cost of the service.

It is not so very long ago since the amount of attendance at schools was the prominent criterion for the amount of the State aid supplied. Mr. Cooke has contended for raising the general status of teachers in the rural districts and for having such additional features as extent of education, experience and good physical equipment, also considered as factors upon which to justify increased legislative aid. Mr. Cooke feels justifiable pride in what has been accomplished in improving the elementary educational facilities of the Province and trusts that by effort and discussion during his many years in the Legislature he has been of some assistance in furthering this program.

In a brief interview which appeared in the public press after his new appointment, Mr. Cooke said:

> "I can only say this, that when I relinquish this position to someone else, I will hand back unimpaired to the Hydro municipalities of this Province those traditions which have made for cleanness of administration in Hydro affairs throughout Ontario."

Those who have observed Mr. Cooke's career in the public interest will—even without this special assurance—know that such a course will consistently be pursued by the new Chairman of the Hydro-Electric Power Commission of Ontario.

The New Commissioner

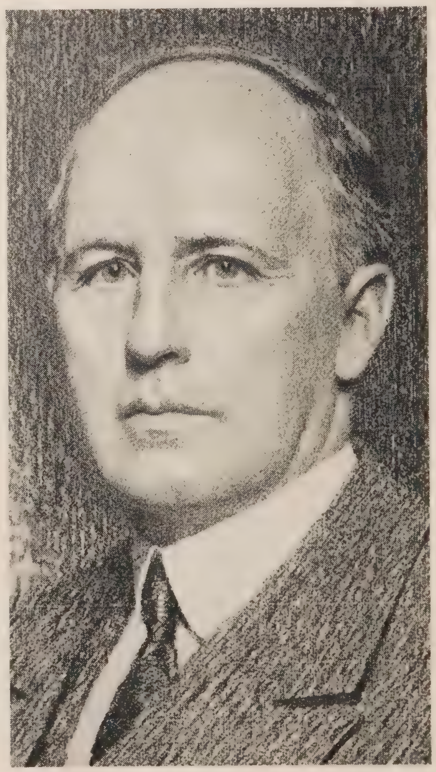
The Right Honorable Arthur Meighen, K.C., P.C.

THE daily press of June 8th published the formal announcement by the Hon. George S. Henry, Prime Minister of the Province of Ontario, of the appointment of the Right Honorable Arthur Meighen as a Commissioner of The Hydro-Electric Power Commission of Ontario. We desire to extend to the new Commissioner a most hearty welcome.

Mr. Meighen needs no introduction to our readers because his name is so well known throughout the length and breadth of the Dominion of Canada. We desire, however, to present in this issue a brief review of some of the important offices he has filled and make mention, also, of some of the outstanding achievements of his well-filled years of public service.

Arthur Meighen is the son of Joseph and Mary Meighen, and was born on June 16, 1874, at Anderson, Blanchard Township, County of Perth, Ontario. His education was begun in the public schools of his native Province, continued at St. Mary's Collegiate Institute and the University of Toronto, from which he received his B.A. degree in 1896. Subsequently, he graduated in Law. In 1898, Mr. Meighen went to Winnipeg, and from there, in 1901, to practise law in Portage la Prairie. He is a Bencher of both the Manitoba Law Society and of the Upper Canada Law Society. He was first elected to the House of Commons as a representative from Portage la Prairie at the general election, 1908, being re-elected in 1911 and 1917. He was appointed Solicitor-General on June 26, 1913; re-elected by acclamation on July 19, 1913; sworn a member of the Privy Council for Canada, October 2, 1915; became Secretary of State for Canada and Minister of Mines, August 28, 1917; and on October 2, 1917, was sworn in as Minister of the Interior, Minister of Mines and Superintendent-General of Indian Affairs.

In 1918, Mr. Meighen accompanied the Prime Minister of Canada to England to attend the Imperial Conference. On July 10, 1920, he was



Rt. Hon. Arthur Meighen

sworn in as Prime Minister of Canada and Secretary of State for External Affairs. Subsequently, Mr. Meighen, as representing Canada, attended the Imperial Conference of 1921, where he opposed renewal of the Anglo-Japanese Alliance, advocating in its stead a wider Treaty to include the United States. The Washington Conference, held later in the same year, brought this Treaty into being, as well as others of lasting advantage.

At the general elections of December 6, 1921, Mr. Meighen was defeated, but later was elected for the County of Grenville on January 26, 1922. He led the Conservative party in opposition until the general elections when he was re-elected for his former constituency of Portage la Prairie on October 29, 1925, and the members of his party in the House of Commons were increased from 50 to 114. Mr. Meighen was again sworn in as Prime Minister on June 29, 1926, but being defeated on September 14, 1926, he retired from the Federal political arena on October 11, 1926.

A public record such as has just been briefly cited is unusual and most noteworthy. The Dominion Hansard which chronicles Mr. Meighen's addresses in the House of Commons as well as his replies to questions and his participation in debates, bears ample testimony to his extensive knowledge as well as to his direct and trenchant dealing with the wide range of subjects with which it was his responsibility to deal. The public press of Canada, from time to time, has borne testimony in many forms to the special ability and public service rendered by Mr. Meighen.

We believe that the foregoing presentation of the prominent features of his public life unmistakably testifies not only to Mr. Meighen's special capabilities, but also shows in what a variety of ways he has throughout many of the best years of his life devoted himself to the public service. It is believed that the work of the Hydro-Electric Power Commission of Ontario and the associated electrical utilities, which touch the life of such a large number of the citizens of Canada, will afford Mr. Meighen exceptional scope for the exercise of his ability and experience and, moreover, will afford him much satisfaction in advancing the interests of the people of his native Province in their important "Hydro" undertaking.

Mr. Meighen on June 1, 1904, married Jessie Isabel Cox, daughter of the late Charles Cox of Granby, Quebec. They have two sons and one daughter. One son, Theodore, is practising law in Quebec City; a second, Maxwell, is metallurgist in the employ of the Steel Company of Canada, at Hamilton. Their daughter, Lillian, is attending the University of Toronto, graduating in Arts this year.

Since retiring from parliamentary life, Mr. Meighen has resided in the city of Toronto, where he has served as Vice-President and General Counsel of the Canadian General Securities, Ltd.

Organizing for Plant Operation and Maintenance

By A. S. Robertson, Operating Superintendent, Queenston Generating Station, H. E. P. C. of Ont.

(From a paper read before Toronto Section A. I. E. E.)

ONE of the first problems confronting the operating engineer of a new plant is the proper selection of staff, tools and plant equipment. The operating staff is practically fixed by the layout of the station, and generally this item is considered during the design of the station when equipment is grouped in such a manner as to require the minimum number of operators.

The selection of a maintenance staff largely depends upon the characteristic load curve of the station. If all major repairs have to be done during the summer months, then a minimum of high class men may be retained all year and sufficient temporary men brought in during the repair season to speed up the work. On the other hand if the load is such that repairs may be carried on throughout the year there is no need for such speedy repair work and consequently it may be done with a reduced staff. Obviously the number of men required for maintenance is also a direct function of the tools and plant equipment supplied.

The machine shop is of vital importance and should, therefore, be very carefully planned. The space allotted should be ample for the tools to be installed, well lighted and ventilated and suitably located to the equipment it will serve. It should be equipped with mechanical handling devices so that a minimum of labor is required in setting-up work. Where an overhead crane is not justified an inexpensive system of trucks

Approach to Queenston Generating Station.

and mono rails with a hand chain block to serve each machine will often serve the purpose. Such a system pays for itself many times over on emergency work.

There are no standard specifications for selecting the necessary tools. They must be selected to give the maximum diversity as to size and operations, keeping in mind that what is required is a service rather than a production shop. The accuracy of individual machines should be specified, depending upon the class of work which they will be called upon to do.

The Value of the Service Shop

Experience has shown that such a service shop is required in spite of the fact that spare parts may be obtained from the manufacturer. Spare parts supplied by the manufacturer are usually not interchangeable without fitting and such fitting requires the use of machine tools. As the plant becomes older spares are difficult to obtain. In most large plants the equipment is not standard and consequently the manufacturer does not carry spares. If an order is placed for a spare part it is highly probable that considerable delay will be experienced due to the fact that the factory is busy on some other order. When it finally arrives it will more than likely have to be fitted, either due to improvements having been made, or to the fact that jigs and templates have not been used. In a good many cases it is found that the anticipated failure of one part causes the failure of an unexpected part. In general this calls for speedy repairs which can only be handled on the job. It is in such cases that a well laid out service shop more than justifies its existence.

Such a shop will attract and hold a high grade of mechanics due to the fact that all year employment is assured. This is accomplished by laying out the work in such a manner that all production work, such as, machining gate links, bushings, etc., is carried out during the heavy load periods. The men doing the machine work are in close touch with the repairs as a whole and consequently are in a position to know the exact requirements of each particular job. With such a shop it is feasible, by means of jigs and accurate workmanship, to standardize on a great many parts, allowing perfect interchangeability, thereby saving many valuable outage hours.

Then we have the organization of the staff, the most difficult to build, which requires just as much care in the proper selection as the shop and tools.

Great care, especially in the early stage, is required in the selection of the workmen to see that they not only have the ability for the job of the present but have the ability to expand with the job of the future. Modern business is accused of having no heart, of being hard and inhuman, yet there are occasional cases where a workman selected for a job has failed to expand with the job and out of unwillingness to admit our mistake, or sentiment, or whatever else you wish to call it, we endeavor to get along with this inefficient human tool to the detriment of the efficient operation of the organization. Hence, it becomes a serious problem to select the proper

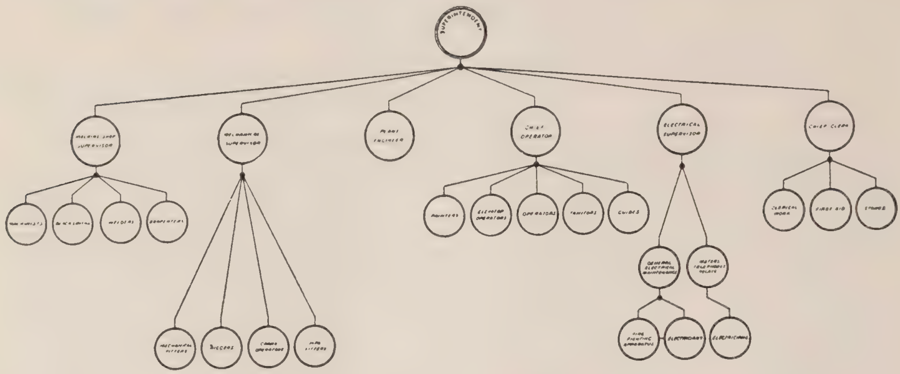


Fig. 1—Organization Chart of Queenston generating Station.

staff that will meet the needs of to-day and also the needs to-morrow.

One difficulty in handling the staff is the changing of business itself. In the olden days the firm usually represented a definite person or persons, the owners of the organization. Because of his personality and his personal interest, the staff had somebody real and tangible to serve. They gave their loyalty to a person—they adjusted their grievances with a real person; in other words, they received personal service, and gave personal service. To-day, business lacks this personality. Many methods of merit have been proposed as to ways and means of stimulating better employees' relations with these unknown owners and the public they serve. However, I believe that the success of all such methods depends largely upon the personnel of the officers and their ability to set the example for the staff to follow.

To illustrate an operating plant organization, I will use the Queenston plant as an example, as this is the one with which I am most familiar.

The organization chart, shown in Fig. 1, sets out very clearly the responsibility of the various sections and sub-sections.

Duties of Operating Staff

In general, the operating section deals with the pure operating problems. This staff consists of ten men per shift, a shift being eight hours. Their duty consists primarily of being responsible for the operation of every piece of equipment, to see that it is operating properly, and to distribute the output of the units to meet the system demands. In addition, they are required to collect and tabulate all the information required for station records.

Another very important duty is the removing of apparatus from service to make it safe for the repairs to be undertaken. This requires a great deal of care, as not only must the men be given the best of protection for their work but also the service must be protected so that it will not

suffer either from lack of capacity or from the work being undertaken by the workman.

They must be on the lookout for conditions which may develop trouble or have developed on the equipment in service. To them falls the responsibility of reporting this on a trouble report and if the failure occurs after the regular working hours they call out the required repair gang.

An operating staff requires a special selection and training, particularly those men occupying the more important positions. It calls for a type of man who has, first, the intelligence to understand the apparatus under his care, who can be depended upon to perform the daily routine jobs day after day with care and precision and be able to rise to sudden emergencies and cooly size up the situation and quickly apply the remedy.

These emergencies arise frequently without any warning, usually with considerable disturbance and at such times it calls for a level-headed man who is unafraid to perform the task and not afraid to use his judgment. Upon his shoulders there frequently rests a heavy responsibility, as he may be dealing with units of 55 to 63,000 h.p. and costing several millions. He has not hours to get out a pencil and paper and study what to do, rather he must act instantly and he has no rubber to erase his errors if his instantaneous judgment should prove to be wrong.

Our maintenance staff is responsible for the maintaining of all equipment and buildings. They have no jurisdiction over the operation of the plant other than assisting in instructing the operating staff in the method of operating a new piece of apparatus.

You will note from the diagram that we have mechanical, electrical and machine shop sections. The machine shop is responsible to the superintendent and thereby renders equal service to all departments. Our shop is particularly well equipped as to personnel and equipment and in our opinion renders a very valuable service to the plant. The machine shop supervisor also handles all the welding work, both in the shop and outside the shop. The grouping of the welding work under this shop means a more efficient use of men and machines because of the wide diversity of work handled in the shop.

The mechanical section is responsible for maintenance of all purely mechanical parts whether on electrical or mechanical apparatus. This section is also responsible for all rigging work and the dismantling of all heavy equipment. It also maintains all buildings and outside structures.

The electrical department is divided into two sections: the general section, which looks after all the heavy equipment, such as generators, motors and oil breakers; the other section looks after the repairing of the meters and relays, control circuits and the generator excitation.

The Winter Season

Generally speaking we have two working seasons, winter and summer. During the winter season, all the main units are required for service. Consequently during this season we overhaul all our service equipment such as elevators and cranes, plant

lighting and power equipment and overhaul all rigging material and plant tools.

This also is our annual house cleaning period and while we have a regular janitor service we have found that it is just as necessary to have an extra special cleaning once per year as it is in the home. This is especially true when it is realized that many of these places to be cleaned require scaffold jobs which are beyond the ability of a janitor to handle.

Preparing Maintenance Schedules

In addition to this we, at this season, do a considerable amount of preventative maintenance in the way of routine inspection and minor repairs. There are two main objects in such inspections. First, incipient faults are often detected which, if not early rectified, may develop into major failures that may not only cause serious damage to this apparatus but also involve other equipment in their failure and cause a general interruption to service and a long outage of apparatus for major repairs. Second, from the information thus obtained from these inspections, the necessary major repairs are determined and placed on the summer schedule.

Our supervising staff begins work as early as possible on the preparation of a tentative program of repairs for the coming summer. This is to permit the ordering of long delivery material and also to keep the shop busy producing for the summer schedule.

These repair items will be finished where possible, others left rough turned, ready for a finishing cut and the shop will thus be kept running with a steady winter load and will be relieved of a great deal of the excess strain of supplying the demand in the summer peak. This results in better workmanship, better use of the shop and reduces the time a main unit may be out of service for repairs.

A final plant inspection is made in March, just after the ice season, and from this information our final summer schedule is made. Such a schedule is illustrated in Fig. 2, upper half. This schedule gives the time of starting of each unit on the repair list, the estimated time of the repairs and the order in which they are to be undertaken.

When this schedule is approved, copies are sent to all shops and sections so that each may organize their staff and tools to co-operate with one another in the maintenance of this schedule. In the example shown in Fig. 2, the upper half shows the proposed and the lower half the actual schedule accomplished. This particular year is not a very good example of our conformity to the estimated schedule, but it illustrates the method very well and it also shows the cause of delays.

Detailed Schedules

The next step is to prepare a detailed schedule for the various known operations on the particular unit in question. Thus, each job of any importance that is to be done on the unit is scheduled and the man power assigned to it. This is necessary to co-ordinate the various maintenance sections and thus prevent, for example, the machine shop from being overloaded one day and slack the next, and to so schedule electrical

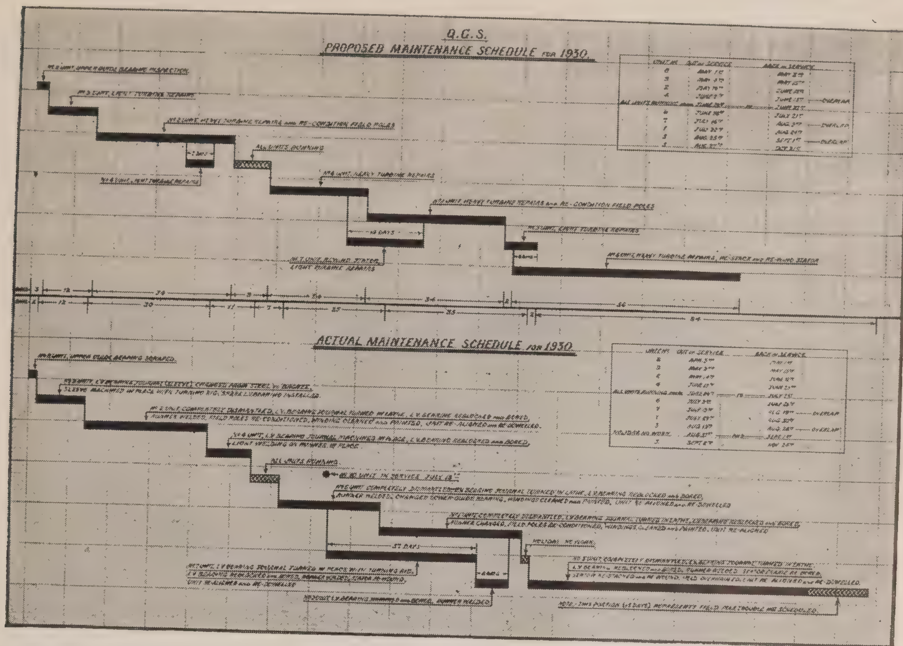


Fig. 2—Proposed maintenance schedule and actual record in days for Queenston generating station.

work that it will not interfere with mechanical work and cause delays due to one section holding up the other.

The progress of such a job is plotted each day so that reasonable control may be exercised over the job. From such records it is readily seen who is behind in their job; and the relative importance of this job to the whole determines whether it will be necessary for this section to either put on more men, if possible, or work overtime. It will likewise be obvious that this also is a very efficient method of checking costs and placing the proper value on the relation of time and costs

There are many different ways that progress records may be kept. However, no matter what system is used for recording cost and progress, it will be of no value in saving anything on the particular job under way unless it is kept up-to-date. Consequently these records are as far as possible kept up-to-date and if we are running three shifts of eight hours they are recorded at the end of each shift.

Reducing Time and Costs

Fig. 3 is an example of a detailed job schedule which covers the work involved in rewinding a large generator. It was from a similar job as this, in which the cost of the job was mainly governed by the machine outage hours, that started us studying such a method of scheduling work. From such a schedule it was possible to reduce the machine outage hours from an estimated time of six weeks, based on previous experience, to one-half of this and at the same time

reduce the estimated labor charges accordingly.

In the past the usual practice has been to do one job at a time, that is, put in all the coils, then the wedges, next solder the connections, etc. Our schedule, however, calls for as many operations to be going on at one time as possible and these operations are so scheduled as not to interfere the one with the other. This naturally accounts for the reduction in time, but the reduction in costs is not so obvious, for naturally the number of men required to do this job is much greater. The saving in labor came

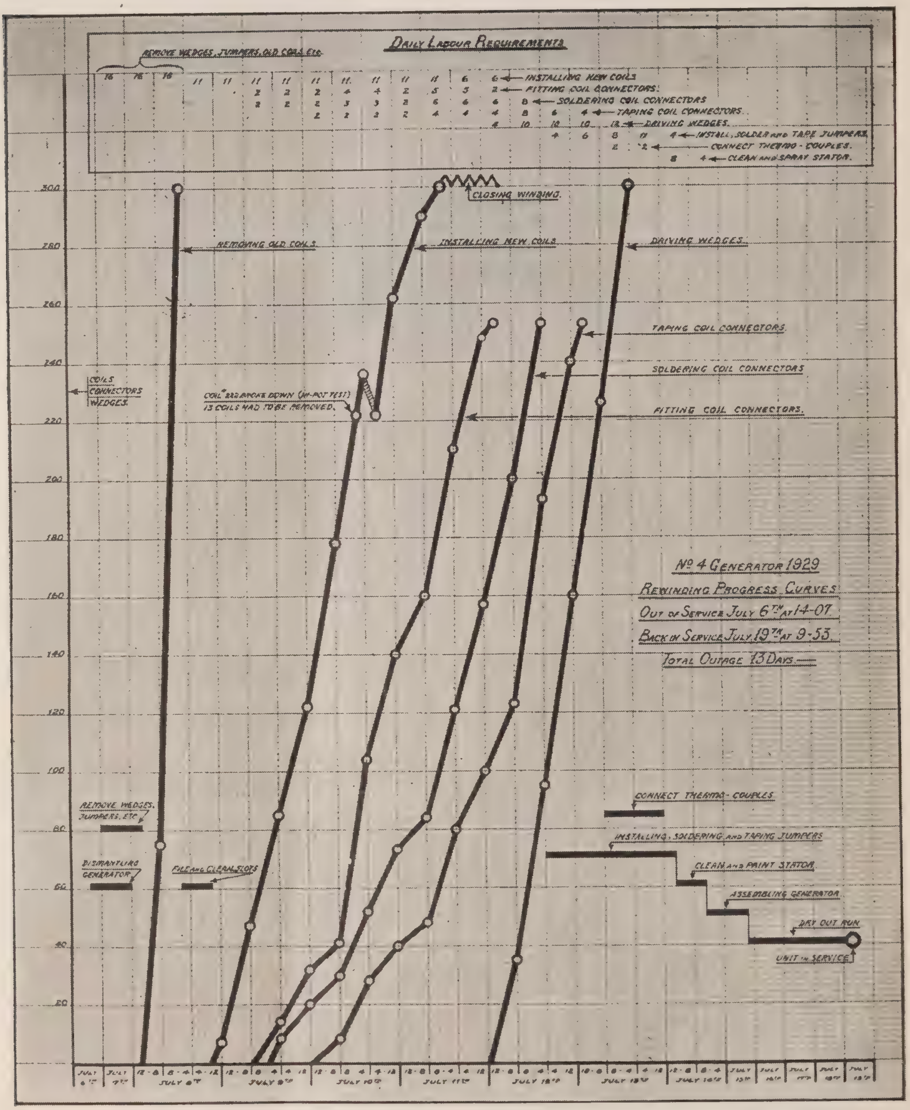


Fig. 3—Example of a detailed job for rewinding a large generator.

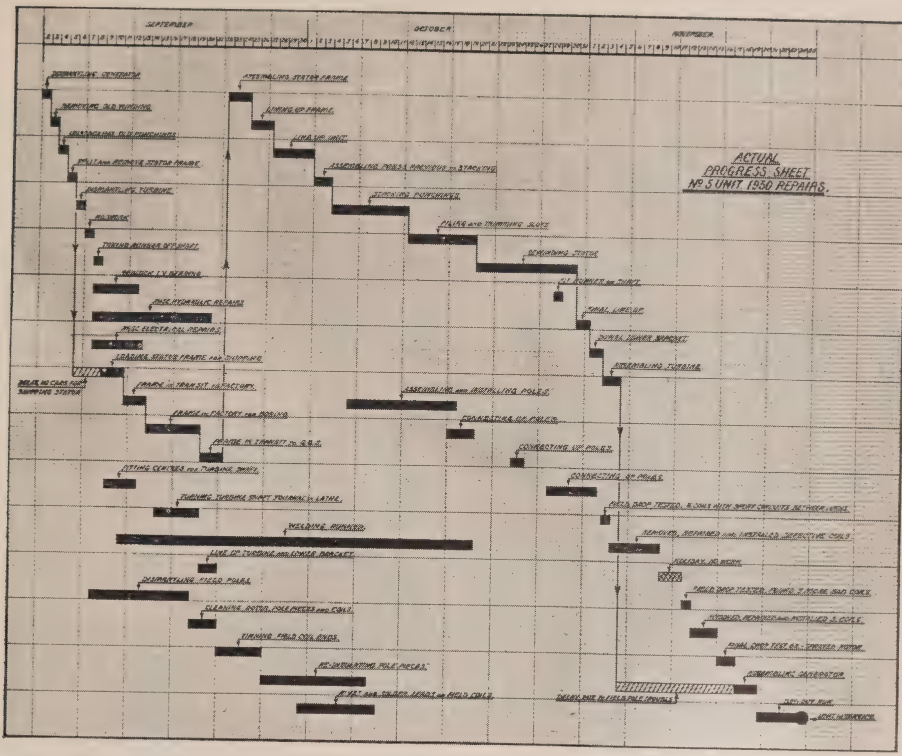


Fig. 4—Assembly of several individual job schedule sheets covering a major repair on a large unit.

by setting the output expected per shift per group of men and by recording their output. After it was understood by the men and they found that the requirements were reasonable, it became a race to beat the previous shift record, which accounts for this 19 day schedule.

Fig. 3 is self-explanatory; the number of coils is a measuring stick for all the rewind operations. At the top is shown the daily labor requirements and indicates the building up of the staff as the job progresses and the tapering off at the end.

It is but fair to point out that the labor requirements of this table cannot always be met economically. We are so organized that we can draw men from the other two generating plants as required and when we are finished we can return them without any inconvenience to the men or the organization. Where such a flexible labor supply is not available the schedule would of necessity have to be altered to meet the labor supply.

Fig. 4 is an assembly of several individual job schedule sheets covering a major repair on a complete unit. It covers every item from the turbine to the generator. This is offered as an illustration of the large amount of information that can be recorded on such a sheet which saves volumes in a written report. The complete history of the repairs, the delays and the order of work are clearly shown. It

also serves as a permanent record for future estimating of time and costs of any one of these particular items which may have to be repaired.

Radio Interference

II

Sources of Interference

IN the last issue of this Bulletin, under the subject: "Radio Interference;—The Noisy Noise in Radio"; it was pointed out that changes in radio receivers may not completely eliminate or prevent interference from sources outside the receiver and that such interference must be silenced at its source, the problem in many cases being to find the source.

A radio receiver of any design has one or more tuned circuits, *i.e.*, resonant circuits which will resonate with, or are responsive to, waves or oscillations of definite frequencies. The tuning-in of a station does not consist in reducing the signal strength of the other unwanted stations but rather in allowing the waves of the desired station to excite these resonant circuits, thereby to produce much stronger effects from these waves than from those of other stations which are coming to the aerial at the same time with equal or even greater strength. The resonant circuits are "tuned" to the radio frequency of the station desired.

While these resonant circuits are responsive to wave trains or continuous waves of definite frequency, however, they will also respond to radiated sudden impulses, such impulses starting oscillations at the frequency for which the circuits are tuned, but with these oscillations being damped out, or rapidly dying down to zero value. It is, to a large extent, the oscillations caused by these sudden impulses, or repetition of these impulses, which constitute interference in a radio receiver.

Such sudden impulses are caused by a sudden change in magnitude of voltage or current in an electrical circuit, or in the atmosphere, e.g., the turning on, or off, of a light or other appliance in the home will almost surely cause a sudden change in current, and in voltage also, and in consequence produces a noise of short duration in the loud speaker: a stroke of lightning, whether to earth or only between clouds, also excites the resonant circuits and is heard from the loud speaker: a discharge on an insulator has a somewhat similar effect.

As explained before, however, if the interference be of very short duration, and not frequently repeated, it is not usually considered very serious. The interference that persists seems to be the more annoying.

Many electrical appliances, while in operation, cause a series of sudden changes in the voltage or current of the supply circuits. Such devices are accountable for a great deal of the more serious interference experienced by broadcast listeners, and should be considered first in a search

for a source of radio interference. In a great many instances, it is possible to turn the appliance on or off for purposes of a test and thereby determine whether or not it be the cause of the interference, or even of part of it.

A number of household and industrial appliances, common sources of interference, are suggested and classified according to the nature and persistence of the interference caused, as follows,—

HOUSEHOLD APPLIANCES

1. *Sudden Impulses of brief duration*—(not usually serious if switches and plugs be in good condition.)
   - (a) Incandescent lamps.
   - (b) Electric Irons, Toasters, Heaters, Peroclators, Ranges.
2. *Series of Sudden Impulses*—Usually serious.
   - (a) Door bells, buzzers, mechanical rectifiers, etc.
   - (b) Motors, having commutators, including those used with washing machines, vacuum cleaners, oil burning furnaces, sewing machines, ventilating fans, toy electric trains.
   - (c) Dial telephones.
3. *Repeated Irregular Impulses.*
   - (a) Heating pads, Refrigerators.
   - (b) Flashing lamps.
4. *High Frequency Impulses—damped.*
   - (a) Violet Ray, Apparatus—Ozonators.
   - (b) Spark discharge apparatus—oil burning furnaces, rotary spark rectifiers.
5. *Faults—Abnormal Operation.*
   - (a) Loose, corroded or otherwise uncertain contacts in switches, extension plugs, fuses, or flexible cords.
   - (b) Lamp loose in receptacle, or parts loose in appliances.

INDUSTRIAL APPLIANCES

The Radio Branch of the Department of Marine has found interference from the following industrial apparatus, even when operating normally:—

- (a) Telephone ringing apparatus,
- (b) Telephone "busy test", "busy signal" and "howler",
- (c) Telegraph keys,
- (d) Stock tickers,
- (e) Mechanical rectifiers of the vibrator type, used for charging batteries,
- (f) Sign flashers, traffic lights,
- (g) Many different types of apparatus in connection with the electric railway systems,
- (h) Mercury arc rectifiers, such as used for street lighting systems,
- (j) D.C. motors, such as are used for elevators and other industrial purposes,
- (k) D.C. generators, used for charging batteries and other industrial purposes,
- (l) Rotary converters such as are used in theatres,
- (m) Ignition systems of internal combustion engines,
- (n) Ignition systems used in connection with oil and gas burning furnaces,
- (o) Electric welders and electric furnaces,
- (p) Electric ozonators used in connection with the ventilating systems of large buildings and the bleaching of flour in flour mills,
- (q) High voltage test apparatus,

(r) Lightning arresters, when being charged,
(s) Electro - medical apparatus, such as X-ray and High Frequency machines,
(t) Induction voltage regulators,
(u) Smoke and dust precipitators,

DISTRIBUTION SYSTEMS

There are several abnormal conditions which may cause radio interference from distribution systems. Some of these are as follows,—

(a) Primary cutouts — contacts loose or base wet.
(b) Lightning arresters—contacts loose or base wet.
(c) Transformers — loose connections on terminal board.
(d) Ungrounded metal—loose or intermittent contact between line wire and ungrounded metal, i.e.,—guy wire, cross-arm bolt or bracket, transformer case, conductors of other circuits.
(e) Cracked or defective insulators or bushings.
(f) Tree contacts—lines over 500 volts.
(g) Semi-conducting material across lines, birds, wet string, wet sticks, etc.

The sources of radio interference are many and varied. The above lists are suggestive only of the types of appliance or equipment which create interference, and many other devices could also be listed as equally objectionable in this feature. At the present time several manufacturers of interfering appliances are supplying suitable filters as part of the device, thereby being able to advertise that their appliances are non-radio-interfering. Wherever such appliances can be so equipped, it should be most desirable to do so.

Practically any means of locating interference seems justifiable. There are some means, however, which have proven more effective than others, and similarly, some methods of suppressing interference have proven very satisfactory. These will be discussed under "Radio Interference, III," in a later Issue.

—*F. K. D.*

The Alexander Power Development on the Nipigon River

By T. H. Hogg, Chief Hydraulic Engineer, H.E.P.C. of Ont.

(Paper presented before Annual General and General Professional Meeting of The Engineering Institute of Canada at Montreal, February 4th, 5th and 6th, 1931.)

(Continued from May Number)

Governor System

Each unit is equipped with a governor actuator, sump tank, pressure tank and oil pressure pump.

The governor actuator contains the electric motor driven flyballs, the pilot and main distributing valves, the gate limit device, the restoring mechanism, and the synchronizing gear, which can be operated remotely by electric motor or by hand. The whole governor setting is so arranged as to be compact and yet of easy access to all working parts. The actuator is of the well-known Woodward type, designed so that all parts are enclosed in a dust and oil-proof housing. The operating device consists of one hand wheel placed near the gauges and gate indicators. With this one hand wheel, it is possible to start the unit and bring it into operation, and an immediate shutdown can also be effected at any time.

As a novel feature for synchronizing an automatic speed matcher is furnished, which takes the place of the ordinary synchronizing motor. This speed matcher consists of two special 3-phase electric motors, one of which is connected to the unit which is to be synchronized; the other motor is connected to the bus. These two motors rotate in the opposite direction, and are directly connected to a differential gear which is placed on the synchronizing gear shaft, which, in turn, lowers or raises the pilot valve stem, thus opening or closing the turbine gates as required. When the frequency of the unit and bus is alike, both motors will be operating at the same speed, and the shaft of the differential mechanism will stand still, under which condition the circuit breaker can be closed.

While the oncoming machine is connected to the power system, it is at any time possible to either raise or lower the speed by operating the bus-connected motor. Such procedure will cause loading or unloading of unit.

In addition to all automatic features for synchronizing, a further advantage is introduced by operating the pendulum through a direct-connected electric motor. Such an arrangement eliminates the belt or gear drive, which is necessarily complicated and cumbersome in vertical machines. The current for this flyball or pendulum motor is obtained direct from a pilot exciter mounted on the upper end of the generator shaft. A special protection device is installed to shut down the unit to any predetermined gate or load in case of defect in the connecting wires.

The actuator housing contains the main distributing valves, gate valves and restoring devices, while, as an additional security, a hydraulic hand control is attached. With the hand control, it is possible to start the unit in case no oil pressure or outside current for the pump motors is available.

The oil pressure system is placed on the downstream side of the power house, and so arranged as to enable dismantling of main generating unit without interference with the sump tank, pressure tank or pump.

Construction Joints and Waterproofing

As an aid to the construction forces, detail plans were prepared for their guidance in the placing of concrete. These plans indicated the location and extent of the various classes of concrete going into the structure and the position of the construction joints. There were also shown the necessary cut-off or key trenches and copper bellows where waterproofing conditions indicated the need. With the receipt of weekly and monthly reports of work done, the progress is readily visualized by reference to these joints in the reports.

The location of the construction joints was largely controlled by the capacity of mixing and placing equipment and the restriction in height governed by the strength of forms for green concrete. It is also necessary to place certain joints at definite points where the stresses in the structure may be properly safeguarded and transferred. Wherever joints extend through a comparatively thin wall or pier against which there will be a pressure of water from either side special precaution is taken to waterproof the joint and to place a copper bellows.

The control of the concrete mixing and placing is an important factor in the construction of waterproof walls in that the density, which is a measure of resistance to penetration, may be fixed by the mix, provided it is properly placed in the forms.

To guard against the possibility of seepage damaging the plaster finish on the control room walls subject to water pressure on the upstream side as well as corresponding walls along the upstream side of the power house, a waterproof brick curtain wall was constructed leaving a space of 5 inches between concrete and brick. This space was provided with offtake drains.

Power House Superstructure

The power house superstructure is 52 feet in width and 203 feet in length by 55 feet high, constructed of steel frame with hollow tile walls faced with brick on the exterior and with plaster on the interior. The main generator room is divided into eight bays each 25 feet long, two of which are required for each unit and the two westerly bays for the erection room and control room. Below the erection room is a basement wherein the oil, water and air supply systems for the generators and transformers are located.

The power house is equipped with a four-motor, electrically-operated crane, having a rated capacity of 95 tons on the main hook and 20 tons on the auxiliary hook.

The heat from the generators is utilized for heating the station during the winter months. Five hundred and fifty-volt, 3-phase, electric heaters are provided to heat the control room and certain other sections of the control bay. Provision has been made for the installation of electric heaters in the headworks section should they be required; normally, the warm air from the generating room will be carried into the headworks section.

For cooling each generator a supply of 55,000 cubic feet of air per minute will be required. By a system of dampers, air from the outside may be drawn in through air ducts to the generators and expelled through monitors in the roof, or, if desired, the air may be circulated through the generators from the generator room or partially from outside.

The passages supplying air to the generators are designed for air velocity of 750 lineal feet per minute while the monitors in the roof are designed for an air outlet velocity of 570 lineal feet per minute. There is one monitor for each generator.

Generators

The three generators were purchased from the Canadian General Electric Company and are rated 15,000 kv-a., 12,000-volt, 3-phase, 60 cycle, 100 r.p.m., 85 per cent. power factor. They are of welded structural steel design, only the guide bearings and bearing housings being cast. The generators are complete with spring type thrust bearing and main and pilot exciters designed to give high speed excitation. The thrust collar of the thrust bearing also acts as a guide bearing so that this bearing can be considered as a combined thrust and upper guide bearing. The lower guide bearing is of the usual design, oil lubricated.

A 3-phase tap has been taken from the armature of the pilot exciter of each generator and run direct to supply the governor flyball motor. This eliminates the necessity of step-down potential transformers and connections to supply the flyball motors and supplies a potential direct to the flyball motor as soon as the generator is rotated, whether the 12-kv. connections are connected to the generator or not.

Thermocouples are embedded at different points around the stator windings, also in the upper and lower guide bearings. The leads of these thermocouples are connected to a selector switch which transfers any thermocouple to the temperature indicator or temperature recorder. There is also a Bristol recording thermometer connected to record the temperature of the thrust bearing.

Transformers

The power transformers consist of three outdoor, 15,000 kv-a., radiator type, oil-insulated, self-cooled, 22,500 kv-a. forced air-cooled, 80 per cent. power factor, 3-phase, 110/12 kv., 60 cycle, 55 degrees rise with four 5 per cent. high voltage full capacity taps above 63.5 kv., connected to manually-operated tap changers. The total weight of each transformer is 98 tons.

The transformers are connected 63.5 kv. star 12 kv. delta. The high voltage neutral lead is brought out of the transformer through a 110-kv. bushing of same design as the phase bushings, except that it is equipped with a potential tap device from which potential is obtained for operation of the relays on the ground protection system. This device eliminates the necessity of 63.5 kv. potential transformers.

Ring type current transformers are installed inside the delta in each transformer, also on the high voltage bushings of the transformers for use in conjunction with the protective relay systems. The neutrals of the transformers are not grounded in any manner as will be dealt with more fully later.

No indicating thermometers are provided on these transformers; instead each transformer is equipped with "hot spot" temperature indicating equipment which can be checked by thermocouples whenever desired. The temperature indicators for these transformers are located in the control room so that the transformer temperatures are constantly under observation of the operators on duty.

Electrical Layout

The single line diagram in Fig. 11 indicates the main 110 and 12 kv. switching and connections of this development.

The entire 12-kv. switching and bus connections consist of metal-clad equipment of latest design, so constructed as to fit the various bays in the station and to form a ring bus system. The capacity of the 12-kv. main bus and all oil circuit breakers is 2,000 amperes. All breakers are interchangeable and one spare breaker is provided so that a breaker can be removed from service in the ring for maintenance and the spare breaker inserted to keep the ring intact. The breakers are all electrically and mechanically

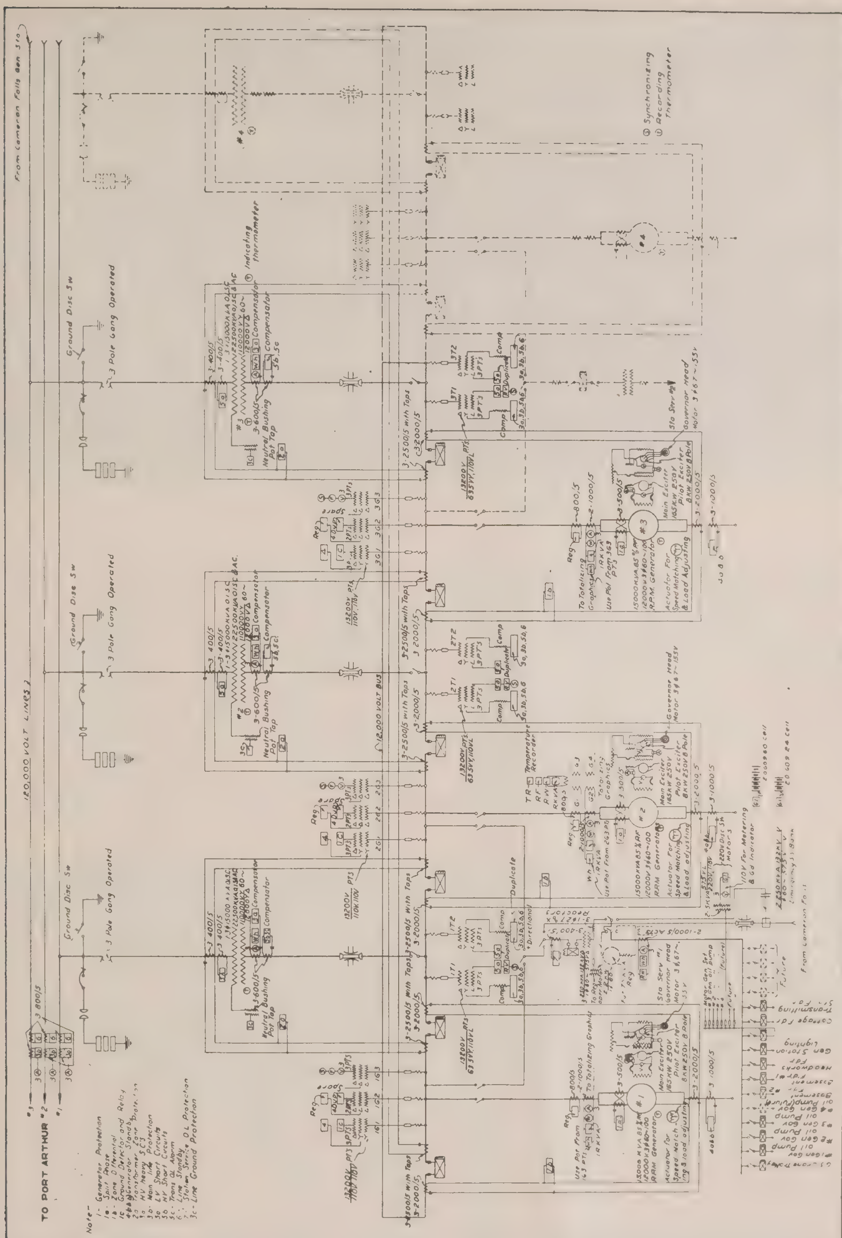


Fig. 11—Line Diagram of Electrical System.

interlocked with the disconnecting switches to guard against faulty operation.

The required ring type current transformers and 3-phase double secondary potential transformers with their primary resistances and protective fuses are all incorporated in the metal-clad structure.

In a bay 21 feet long by 16 feet wide and 12 feet high, a metal-clad switching unit is installed consisting of two electrically-operated, 15,000-volt, 2,000-ampere., 3-pole, oil circuit breakers with 12 kv. bus sections, two 3-phase, motor-operated, oil-insulated, disconnecting switches, 12 ring-type current

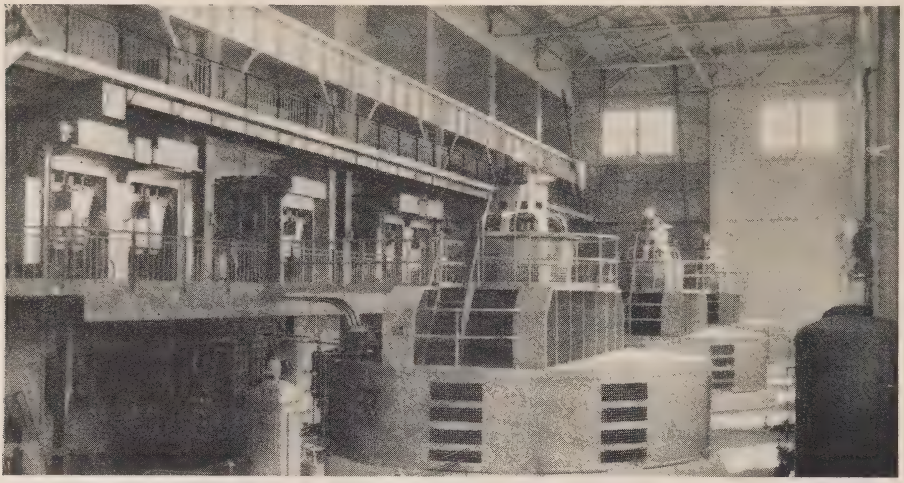


Fig. 12—Interior view of the Power House.

transformers and five sets of oil-insulated, three-phase, double secondary potential transformers with primary protective equipment; this will give some conception of the compactness of this equipment. The equipment is designed for a potential test of 60,000 volts for one minute. It is designed to control the three 15,000 kv-a. three-phase transformers and station service transformer banks and may be extended at one end in future.

From the ring bus system, six 1,000,000-c.m., 12,000-volt, P.I.L.C. cables are run underground in fibre ducts to each of the outdoor, 3-phase transformers. The connections from the metal-clad service breaker to the outdoor station service transformers are also run underground.

Where the 4-inch ducts are run from below the generator room floor up to the metal-clad structures, a rise of 14 feet 4 inch rubber hose was used instead of fibre or metal conduits. This eliminated the difficulty of fitting fibre duct sections for a vertical spiral run 25 feet long or bending metal conduits to fit properly. The rubber hose was filled with fine sand, capped at both ends and placed in position to which it readily conformed and the concrete poured around it. After the concrete had set the sand was run out and rubber hose joined to the fibre ducts in the main horizontal duct run.

The three 15,000 kv-a., 3-phase transformers are located outdoors approximately 250 feet from the generating station and mounted on concrete foundations. The transformers can be transported between the erection room of the generating station and transformer station by means of a specially designed transfer truck which is run on a standard gauge railway, the rails of which are placed on concrete foundations.

The 110-kv. switching equipment consists of an electrically-operated 3-pole air break disconnecting switch. There are no 110-kv. oil circuit breakers or bus connections. The arrangement whereby these are eliminated is explained later. The power transformer banks are considered as part of the 110-kv. line and all automatic clearances are cleared by the low voltage breakers in the ring bus system, except infeed faults, in which case the line breakers at the receiving stations operate also. This system of connections involves a considerable saving in the cost of 110-kv. switching and connections.

The three 110-kv. lines from this development are connected at a special line tap steel structure erected on the transmission line right-of-way direct to the three transmission lines running from the Commission's Nipigon development to the Port Arthur transformer station.

The design of this line tap structure is interesting in its simplicity as will be noted from the layout. The structure is designed to accommodate a future fourth line. On the arms of the structure, it will be noted three 110-kv., oil-insulated, double secondary, ring type, current transformers are mounted on each of the three outgoing lines. These current transformers are required for the total line current indication and line protective relay systems.

The current transformers are constructed of two upper sections of oil-filled, 110-kv. porcelain transformer bushings bolted together by a flanged casting at the centre. At the flanged section the current transformers are located and covered with a weather-proof housing.

Control System

The entire station is controlled electrically

from a central control desk located in the control room. The miniature type of control equipment is used on this desk, the top of which for the three present and one future unit measures 72 by 30 inches. The control switches are all of the standard telephone type. Forty-eight volts d.c. is used for the miniature control, which in turn connects in 125 volts d.c. for operation of the various switching units.

The synchronizing system consists of synchronizing across any of the 12-kv. breakers in the ring bus system. As there are potential transformers on both sides of each breaker, it is possible to synchronize across each breaker. Automatic synchronizing equipment is being provided, but in case of failure of the automatic equipment a manual synchronizing system is installed as a standby.

None of the 12-kv. oil circuit breakers in the ring bus system can be closed unless first synchronized. By operating a breaker key on the control desk to close a breaker, this key first connects in the speed matching motors of the generator to be connected to the bus, and at the same time selects the proper potential for the automatic synchronizing equipment; the automatic synchronizing equipment is then connected; this functions and when the proper synchronizing point has been established, energizes the control relays which close the breaker.

If a generator is already running and connected to the bus, and it is desired to close in the other breaker, thus completing the ring, the control is so interlocked that the synchronizing system will operate to close the breaker as usual, but the speed matching motors of the unit would not be energized, in such a case the automatic synchronizing equipment checks for voltage difference only and not for phase displacement.

The entire switching at the Alexander development will later be handled by remote control from the Nipigon station.

Protective Relay Systems

The Thunder Bay system has approximately 30 per cent. of its connected load as synchronous motor load, which is very sensitive to voltage disturbances. The system is, therefore, being arranged as a series of 110 kv. lines metallically isolated from each other. These are connected to the generating and receiving station transformer banks. There is no essential oil breaker switching at 110 kv., only line disconnecting switches being required.

Parallel is held by the ring bus connections at generator voltage between the groups of units in each generating station and at the receiver station networks.

It is intended to promote stability by a layout of the system such that the effect of a fault on the system voltage will be localized and minimized. In other words, it is necessary to maintain at all times some tie between generators and the bulk of the synchronous load, which will retain some voltage to maintain synchronous torque. In addition, it is also necessary to provide an installation of switching and relaying which will enable any fault to be cleared from the system selectively and rapidly.

The relay protection for the Alexander station consists chiefly of zone protective

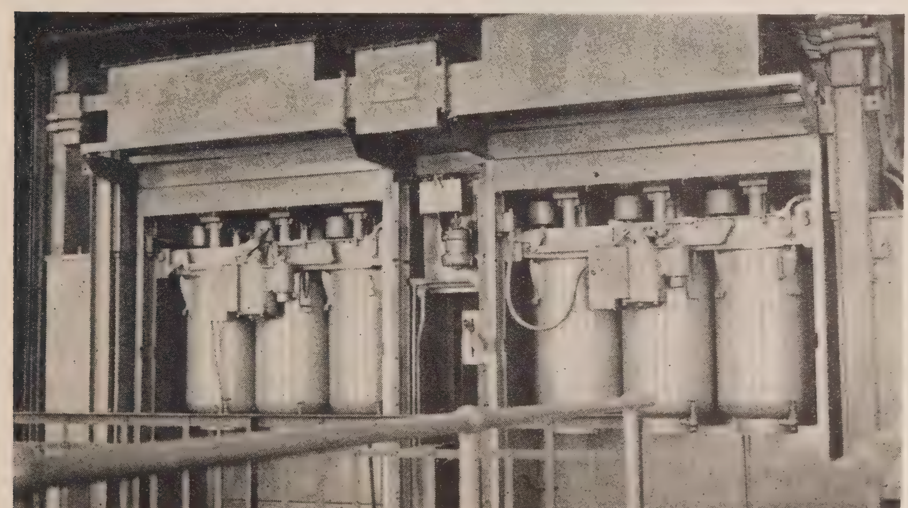


Fig. 13—Metal-Clad Circuit Breakers.

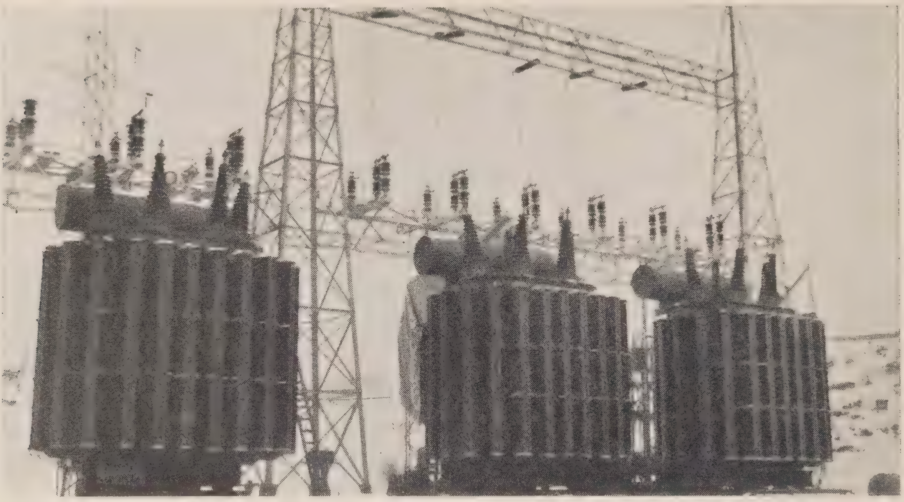


Fig. 14—Transformers.

systems, as will be noted from the single line diagram. The systems consist of the following:—

Generator Protection

Split Phase

This operates on unbalance between the halves of each winding and will operate on a single short circuited coil. This protection is also very sensitive to short circuits in field poles.

Zone Differential

This operates on any unbalance in the phases on any part of the generator circuit from generator neutral to bus side of the 12 kv. breakers in the ring bus.

Generator Ground Protection

(1) Heavy range—segregates units.
(2) Light range—alarm only.

Transformer Protection

Zone Differential

Covers bank from the H.V. bushings to bank breakers in the low voltage ring bus, including the 12 kv. underground cables.

There are three ranges to this system:

(1) Heavy—instantaneous.
(2) Medium—time.
(3) Light Setting—time, for incipient faults.

As there is no oil circuit breaker on the 110 kv. side of the transformer bank, means must be provided to cause the breakers to trip the line at the other stations. To do this, one phase of the line connected to the respective bank is automatically grounded. This causes the instantaneous ground relays to operate on the line at the other stations. This automatic grounding switch is mounted on one phase of the 110 kv. air-break disconnecting switches at the outdoor transformer station.

110 Kv. Line Protection

The line protection differs from the station protection in that distance current potential type relays are used. There are three systems for this protection:

(1) Non-directional. Short range instantaneous short circuit protection. Includes transformer bank.
(2) Main line protection.
Long range S.C.
Short range S.C.
Duplicate.
Directional.
(3) Line ground protection.

As the neutrals of the transformer banks at the generating stations are not grounded, a faulty line will first clear on the ground current relays at the transformer station where the bank neutrals are grounded. For a ground detector at Alexander, a tap is used in the transformer neutral bushing with potential network to indicate voltage from bank neutral to ground, this indicating a ground on the line. With this, a ground potential relay is used to trip the line at the generating stations through a line relay, which permits the breaker at the transformer station to operate first.

In addition to the above, there are the standby protective systems and station service bank protection.

Auxiliary Systems

The station service banks consist of three 250 kv-a., oil-insulated, self-cooled, 60-cycle, 12,000/575-volt, single-phase transformers for the main bank, and two 250 kv-a. transformers in open delta for the standby bank.

The main bank can be connected off either of two generators through double-throw, 12-kv. oil-immersed, disconnecting switches.

The standby bank can be supplied from the Nipigon station.

The station service banks are located about 100 feet outside the main entrance to the generating station on concrete foundations. The 12-kv. and 575-volt cables from and to these banks are run underground. The 12-kv and 550-volt structure over the transformers is constructed of 2-inch galvanized iron pipe with standard galvanized threadless fittings.

The secondary cables from the service banks are run to a 575-volt bus in the generating station. Power can be obtained from either the No. 1 or No. 2 banks through selective disconnecting switches. The service power is supplied to the various service mains by underground lead-covered cables, the feeders being controlled by automatic oil circuit breakers with series ammeters mounted on same. All electric motors in the station on the auxiliary equipment are designed for starting at full voltage across the line.

The mechanical equipment comprises air compressing equipment, including a compressor operating at 100 pounds, pressure for general purposes and generator brakes, and a high pressure compressor for supplying air to the governor tanks; these two systems are interconnected. The water pumping equipment includes duplicate pumps for supplying cooling water for the generator thrust bearings and general purposes throughout the plant. A fire pump is also installed and arranged to come into service automatically if a fire line valve is opened.

The generator lubrication equipment consists of a unit oil system for each generator, the pump being driven by a 550-volt motor supplied from the station service system. Connections are run from each unit system to a central filtering and storage system in the station basement.

The transformer oil storage and filtering systems are located in the station basement and can be connected to the main and service transformers by flexible metal hose at the respective outdoor units.

Closure of Diversion Channel

Construction work proceeded rapidly in all sections of the development throughout the summer of 1930. By the third week in September, the fill in the main dam was brought to elevation 681 throughout its length, the head gates were in place in front of each of the turbines, and a week later the gap in the auxiliary dam, through which the construction railway had passed, was closed, and No. 3 generator was completed. By this time also, arrangements had been made for closing the outlets of the diversion channel and raising the headpond to operating level.

For several days before the closure, the headpond levels at the Nipigon station were regulated to meet the period of shutdown without wasting into the Alexander reach, and to allow ample time to draw down the Alexander headwater pool to permit the steel gates to be placed in the diversion sluiceways.

When the time came for making the closure, the gates were assembled above their respective openings, and suspended on "A" frames, in readiness for lowering into the checks. On Sunday, September 28th, at 4 o'clock a.m., the Nipigon plant was closed down, and the flow in the river completely stopped, the forebay at the Nipigon plant receiving and holding the whole flow of the river coming down from Lake Nipigon, this having been reduced by partial closure of the Virgin Falls dam. At 7 o'clock a.m. the water in the river below Cameron Falls and between the main coffer dam and the earth dam had drained out so that only a very shallow flow was passing through the two sluices. This enabled the gates to be dropped into place without difficulty after the sluices had been thoroughly inspected for any possible obstructions in the way of waterlogged timbers or gravel. Practically no obstructions were found, and the gates were dropped into place and sealed. At 10.25 o'clock the entire closure had been completed, and word was given to the Nipigon operators that that plant could be placed on load again, and at 10.45 o'clock the station was again carrying load. The load during that day proved to be fairly light, and the headpond filled slowly. Early the following morning, water began to flow over the spillwall, and by evening was passing over to a depth of more than 3 feet. With a few minor exceptions, the structures proved to be entirely watertight. A very small leakage through the closure gates was stopped up by dumping cinders against the upstream side and allowing them to be carried into the openings by the current.

The concrete fill or plugs for the water passages behind the gates have been poured, and the upper lift sealed to the lower surface of the existing concrete with grout forced through 10-inch vertical pipes left projecting through the spillwall.

The first unit was turned over on October 1st and the plant first carried commercial load on October 21st.

All work in connection with the development was handled by the Commission's staff.

Limitations in Synchronizing

By H. S. Baker, Meter Engineer, H. E. P. C. of Ont.

IN the following, the relationship between synchronizing errors and the resulting ampere transfer has been analyzed and a number of oscillograms have been submitted to check the results. The oscillograms show the actual values of speed difference and phase difference at closure and also show the resulting ampere transfer. Some discussion is offered as to the relative merits of hand and automatic synchronizing.

In hand synchronizing, the limitations of speed difference and phase difference at the moment of closure are learned in a very crude manner by the hard knocks of experience. The personal element is depended upon to avoid dangerous closures, and this same personal element feels the urge to make all haste to get generators back on the bus after a shake-up in order to keep the total generator capacity always greater than the rapidly oncoming load. One result is that too much is expected of the personal element and that generators probably get occasionally overstrained without the cause or extent of the damage ever being known.

With automatic synchronizing it is possible to set the above speed difference and phase difference limitations to known values, and it is the object of this paper to determine in a rational manner the values of these limitations in order to be able to make the necessary adjustments to automatic synchronizing devices.

After a generator is synchronized to a bus it swings mechanically ahead of and behind the bus for a time in the same manner that a pendulum will swing. This oscillation is a case of what is called simple harmonic oscillation or sine wave variation.

We will then start with a fundamental law of harmonic oscillation expressed in the equation :

$$D^2 = d^2 + \frac{v^2\,t^2}{39.3} \qquad \ldots\ldots\ldots\ldots (1)$$

Where

D = the maximum value of the generator rotor swing ahead of or behind the bus and is measured in radians of angle at the generator rotor;

d = an instantaneous value of the above displacement when not at the end of the swing and is expressed in the same units;

v = the difference in angular velocity between the generator and the bus at the moment when the value "d" obtains and is expressed as radians per second of the generator rotor; and

t = the number of seconds of a complete double swing of the generator ahead of and behind the bus.

The value of "t" is easily measured with a stop watch by observing the generator kw. meter after synchronizing, or by examining an oscillogram.

The value of "D" is determined from the maximum allowable ampere flow during the oscillations following synchronizing. It is also dependent upon the inherent reactance of the generator, and the system fed by the generator.

To find "D", we will calculate a specific case which should explain itself. Take the case of a generator of say 11.8 per cent. inherent reactance based on 10,000 kv-a. This kv-a. is 480 amperes, 3-phase, 12,000 volts.

This generator is being synchronized to a bus that is equivalent to another generator of say 2.53 per cent. reactance, bringing the total reactance up to 14.33 per cent. based on 480 amperes.

If now, before closure, the generator and bus voltages (or field fluxes) were say 60 degrees apart, then the vector difference of generator and bus voltages would be equal to the generator voltage, which is called 100 per cent.

Consider now a generator closed to the bus with its field flux 60 electrical degrees out of step. We now have the above 100 per cent. voltage urging current to flow in a reactive circuit that requires 14.33 per cent. voltage to produce 480 amperes. The 100 per cent. will produce 480 x 100/14.33 or 3,350 amperes, for a magnetic displacement of 60 electrical degrees.

Taking amperes as proportional to the chord of the arc of the displacement angle, for one electrical degree we would get 3,350/57.3 or 58.5 amperes. The chord of 60 degrees is 57.3 times the chord of one degree.

Let us choose about full load or say 480 amperes as the maximum allowable current following synchronizing. This is not high enough to disturb the bus voltage as is shown on oscillogram No. 33. Even if this value of r.m.s. amperes were totally displaced for the first cycle or two it should not damage the generator windings. We will then take 480 amperes as the limit of transfer between generator and bus. This means 480/58.5 or 8.2 electrical degrees is the maximum flux difference swing allowable after the generator is on the bus.

This flow of high power-factor amperes in the generator windings causes a cross-magnetization of the pole faces which causes the magnetic centre of the pole faces to depart strongly from their mechanical centres. The result of this is that (following closure) the departure of the rotor pole centres from their in-step position is much greater than the departure of the magnetic centres of the pole fluxes from the in-step position. We have taken the ratio of these two departures as 1.75 which is approximately justified by the agreement of calculated and measured results on two different makes of generator. The generator in question had 16 poles, or 8 cycles per revolution.

The above limit of 8.2 electrical degrees after closure would give us a limit of 8.2/8 mechanical degrees neglecting cross magnetization, or would, in fact, with cross magnetization, give us a limit of 1.75 x 8.2/8 = 1.8 mechanical degrees on the rotor, or .0314 mechanical radian, which is the value of "D".

The value of "t" is easily read from the oscillograms shown, or taken by stop watch, as 0.87 second.

The above equation (1) with the values of "D" and "t" supplied, becomes :

$$(.0314)^2 = d^2 + \frac{v^2}{52} \ldots\ldots (2)$$

This means that if the speed difference "v" be zero then the value of

"d" to produce 480 amperes is .0314 radian at rotor at instant of closure.

In other words, if there is no difference in speeds, and the generator rotor is .0314 radian from the in-step position, it may be closed to the bus and cause 480 amperes to flow. Just before closure (when there is no cross magnetization of the poles) this .0314 rotor radian means .0314 x 57.3 x 8 or 14.4 electrical degrees out of step for both flux and pole position. However, immediately after closure, while the mechanical displacement is the same as before, yet the magnetic centres of the poles have suddenly shifted and we must divide this 14.4 by 1.75 and get the 8.2 electrical degrees after closure mentioned above as causing 480 amperes to flow.

Let us now find the maximum allowable speed difference, which is when "d" equal zero at closure.

Substituting zero for "d" in equation 2, we get "v" equals 0.226 mechanical rotor radians per second, or 0.289 cycles per second difference in speed of generator and bus.

Equation 2 represents the speed difference and displacements of mechanical parts which do not change suddenly at closure. It also represents the speed difference and mechanical displacements of fluxes immediately before closure when there is no cross-magnetization.

We will then write "d" in electrical degrees and "v" in cycles per second and the new equation (3) will represent electrical conditions just before closure, that will produce 480 amperes swing after closure. We then have:

$$(14.4)^2 = d^2 + 2490\, v^2 \quad \ldots\ldots (3)$$

Where d = electrical degrees and
v = cycles per second.

Here again if d = 0,
v = .289 cycles per second.
and if v = 0,
d = 14.4 electrical degrees.

For cases where both speed difference and phase difference are present just before closure, equation 3 gives the relation between "d" and "v" to cause 480 amperes transfer after closure. If "v" be plotted horizontally and "d" be plotted vertically we get an ellipse whose centre is at the origin. The maximum ordinate is 14.4 electrical degrees. The maximum abscissa is 0.289 cycles per second. The performance curve of an automatic synchronizer adjusted for this case, if plotted in electrical degrees closure error against given speed differences in cycles per second, must lie entirely within the above ellipse. When we have adjusted the synchronizer so that its curve is just within the above ellipse, then we get the quickest synchronizing consistent with safety. In hand synchronizing it is necessary to stick to smaller errors, if possible, and take longer to get the generator in service.

Oscillograph Tests

We will now describe a series of oscillograph tests which were taken on 25 cycle, 12 kv., 8,770 kv-a. generators with the object of checking the correctness of the above method of calculation. Sixteen of the shots were taken with beat voltage curves preceding closure, and ampere flow following closure.

The rate of decrement of the beat volts gives the difference in speed of generator and bus, while the value of

beat voltage at closure gives the phase error at closure. The resulting amperes at closure can be scaled from the ampere curve at the instant of closure assuming the line of wave tips is carried back to the instant of closure. The measurement is taken from tip to tip (allowing for calibration constant,) and represents symmetrical r.m.s. initial value. In a few cases the amperes are small at closure and the following surge is greater. In these cases the following surge value is shown in the tables below.

The line of decrement of the beat volts is taken as a line through the point of synchronism on the zero of the beat voltage curve, and drawn parallel to the tips of the beat voltage waves. On films that do not show the point of synchronism a line is struck, paralleling the beat wave tips in keeping with the films that do.

The apparent failure of the beat voltage wave to come to zero at synchronism is mainly on account of the fact that the light generator voltage wave had a fifth harmonic component that was practically absent from the bus voltage wave form (or vice versa). The generator voltage was held close to the same value as the bus voltage before all shots. The calibrations of the voltage and current curves are all in terms of r.m.s. volts and amperes per inch measured from tip to tip of the wave. Thus the line taken as the line of decrement of the beat volts represents decrement of r.m.s. values.

We will follow through the calculations on one film (say Shot No. 26).

From the ampere curve it is noted that the film speed is 4.3 cycles per inch. Note that alternate ampere surges are reversed in polarity giving forward and backward power swings.

The point of synchronism A is marked on the zero line of the beat volts curve, and a point B is laid off one inch to the left of A.

The line AD is drawn parallel to the tips of the beat voltage waves.

The distance BD is measured and doubled to give the tip to tip reading which represents r.m.s. beat volts.

The calibration of this curve is 7 r.m.s. volts on potential transformer secondary for one inch tip to tip of wave. This means four electrical degrees per inch tip to tip. The distance B to D measures to be 0.53 inch which means 4.24 electrical degrees.

The speed difference is then 4.24 degrees per 4.3 cycles which is .068 cycles per second.

The distance C to E measures 0.83 inch which means 6.6 degrees phase error just before closure.

The ampere calibration was 198 r.m.s. amperes per inch tip to tip.

The initial symmetrical r.m.s. rush was then F to G or 1.46 inch or 290 amperes.

The second ampere maximum was H to I or 0.85 inch or 168 amperes.

Equation 3 gives the relation of "d" and "v" when "D" is fixed but if "d" and "v" are known it becomes equation 4 in electrical degrees and cycles per second.

$D^2 = d^2 + 2490\, v^2$ . . . . (4)

Substituting 6.6 for d and .068 for v we get:

D = 7.4 degrees.

But —14.4 degrees produced 480 amperes.

Hence 7.4 degrees will produce 248 amperes, as calculated from the synchronizing errors read from the oscillogram No. 26.

The actual amperes as shown on the ampere curve extended back to the moment of closure is 290 amperes. This calculated value is then 14 per cent. below the measured value. In cases where the measured amperes at closure are smaller than the following surge, then the surge value is recorded instead of the value at closure.

The following table gives the comparison of calculated and actual values for sixteen shots on a C. W. Co. generator rated at 422 amperes, 12,000 volts:

The above table appears to justify the method described, of calculating ampere transfer from given errors, or of calculating allowable errors from given allowable ampere transfer.

These sixteen hand shots were made by four operators and all were requested to make as heavy shots as they felt safe to make. It often happened however that an attempt to make a poor shot resulted in a good shot. There were only about three of the shots considered by the operators as poor shots. Not one of the thirty-nine shots that were made in the complete series caused the operation of the instantaneous reverse power relay which was set at 10,000 kv-a. The twenty-three

TABLE OF SIXTEEN HAND SHOTS

Shot Number	Speed Difference in seconds per rev. of scope. (fast or slow)	Phase Difference in 1/8ths inch on 3-in. pointer of scope. (early or late)	Ampere rush Calculated from speed and phase errors	Ampere rush measured on oscillogram
12	18.3 F	1.7 L	161	142
13	13.7 F	3.6 L	312	300
14	24.4 S	0	69	70
15	21.9 S	3.0 L	252	268
16	27.3 F	0.5 E	73	70
17	16.3 F	0	102	74
18	15.5 F	0	107	93
19	19.2 S	2.3 L	201	193
22	11.8 F	0.4 L	146	135
23	19.2 S	1.4 E	143	177
24	33.8 F	0.4 L	37	61
25	24.4 S	0	69	65
26	14.7 S	2.8 L	248	290
27	12.4 F	4.9 L	415	545
36	7.9 S	0.6 L	215	161
37	6.6 F	3.1 L	352	287

shots not tabulated above will be referred to later.

The following list includes all of the thirty-nine films which were exposed, and gives the objects of the various shots and other details.

The initial rush of amperes as shown on the oscillograms shows a sudden logarithmic decrement lasting a few cycles. This is not taken cognizance of in the above calculations but in spite of this the calculated results agree well with actual values.

The damaging effect of the displacement of the first cycle or two of the ampere transfer, from its central position about its zero line, is not considered in the above, except in as far as the choice of full load current as a safe value allows sufficient factor of safety to take care of this displacement.

Complete List of Films Exposed

Shots 1 to 3: were high speed films to show the high power factor of transfer amperes following synchronism. The voltage curve is a to b volts while the ampere curve is (A—B) amperes which should fall in step with, or opposition to, the volts at unity power factor. Oscillogram No. 3 is attached below and shows high power factor of transfer amperes.

Shots 4 to 7: were low speed films on a G.E. generator and were taken to show continuation of power oscillation following closure to the bus. Oscillogram No. 7 is shown in which the ampere surges are alternately in step with and in opposition to the voltage wave.

Note:—Also on the film No. 12 (which is on a generator of another make) that the surges die out more rapidly.

Shots 8 to 11: were intended to show the relation between calculated amperes and actual amperes as explained above. These four shots were taken on a C.G.E. generator which is of a different make from the generator on which the Shots 12 to 19 were taken.

The ratio of actual mechanical displacement to effective magnetic displacement from the in-step position is, for the C.G.E. generators, taken the same as before, namely 1.75, and the results show this figure to hold for both makes of generator.

All four of these oscillograms are shown, and it will be noted that the

TABLE OF FOUR HAND SHOTS
(The value of t in this case is 0.9 seconds)

Shot Number	Speed Difference in seconds per rev. of scope. (fast or slow)	Phase Difference in 1/8th inch on 3-in. pointer of scope. (early or late)	Ampere rush Calculated from speed and phase errors	Ampere rush measured on scillogram
8	13.2 S	0.7 L	133	126
9	17.2 S	2.7 L	232	210
10	29.4 F	0.7 E	79	95
11	42.2 F	0.8	74	80

beat voltage does not go to zero after closure, but still exists to some extent and is also noted to be effected by the ampere transfer.

The reason for this is that a wrong potential transformer was chosen to represent bus voltage.

The transformer was beyond a step-up and step-down power transformation. In these shots equation 4 becomes:

$$D^2 = d^2 + 2330\ v^2$$
$$\text{because } t = 0.9 \text{ sec.}$$

Shots 12 to 19: taken on C. W. Co. generator and tabulated above. All these oscillograms are shown below.

Shots 20 and 21: Exposure failed.

Shots 22 to 27: Tabulated above and shown below.

Shots 28 to 35: Taken to measure bus voltage pulsations produced by power oscillations following synchronizing. The voltage pulsations were too small to measure. The oscillogram with the heaviest ampere flow of the eight shots is shown below. It is Shot No. 33.

Shots 36 and 37: Tabulated above and shown below.

Shots 38 and 39: Films buckled in holders and were destroyed.

Conclusions

1. Hand synchronizing throws a heavy responsibility upon personal skill and judgment. This is hampered by unavoidable errors of the synchroscopes when in motion due to the necessary damping or friction in the scopes.

2. Hand synchronizing, if not carefully supervised is very apt to become more and more rough until some relay operates or some damage is discovered which is charged to repeated rough shots.

3. A generator may become damaged by rough synchronizing and the damage may never become known, but the generator insulation might carry on in a weakened condition.

4. Hand synchronizing is apt to be rough in cases where great haste appears necessary.

5. Automatic synchronizing can be set to definite limits of roughness. If these are placed as high as consistent with a good factor of safety, they are high enough to get the quickest safe synchronizing when haste is necessary.

6. Theoretical analysis checked by oscillograms of twenty shots indicate that it is possible to assign limit errors in synchronizing to keep within a given limit ampere flow following closure.

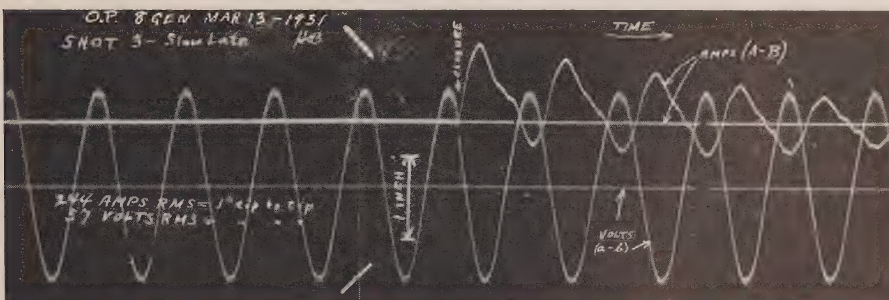
7. Automatic synchronizers can be set to refuse all possible shots whose errors are excessive and take the earliest possible opportunity for closure.

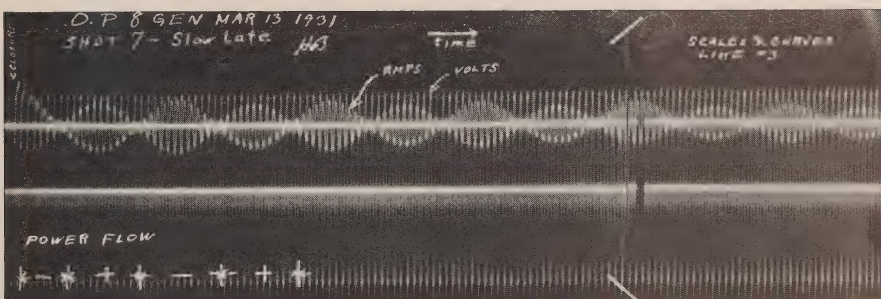
8. In the calculation of errors, a constant 1.75 has been used, representing the ratio of mechanical swing to magnetic wing of a generator after closure. It may be, that when a large number of tests have been run on various sizes and makes of generators, this constant may have to be modified. The constant was chosen of a value to make the calculated values average out with the measured values, for the data available to date.

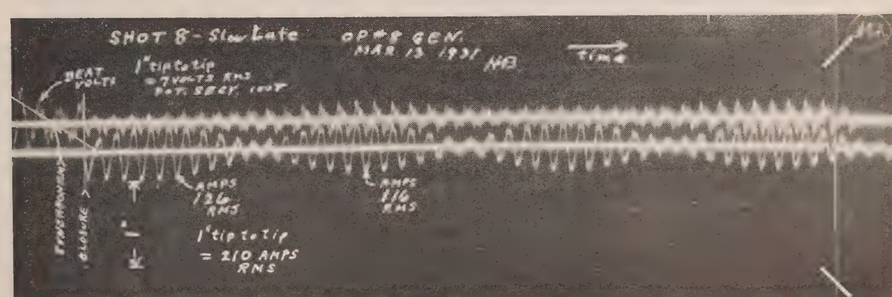
9. It may be felt that if synchronizing is entrusted to a more or less complicated mechanical device, the risk of dangerously rough closure

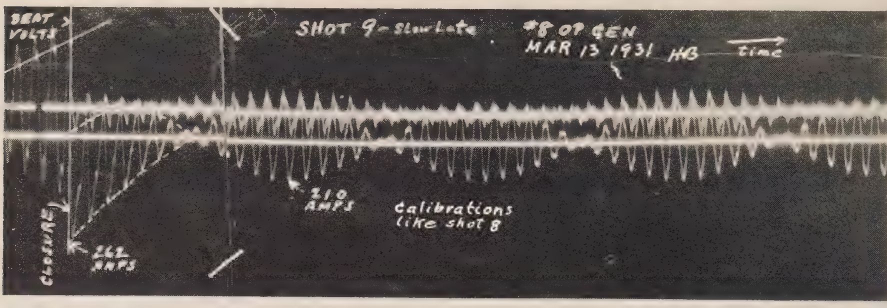
due to mechanical defect would be serious. This risk can be practically eliminated by the use of a simple master device fed from the beat voltage on the opposite phase from the phase that feeds the synchronizer. In this way the potential transformers that feed the master device are not the same ones that feed the synchronizer itself.

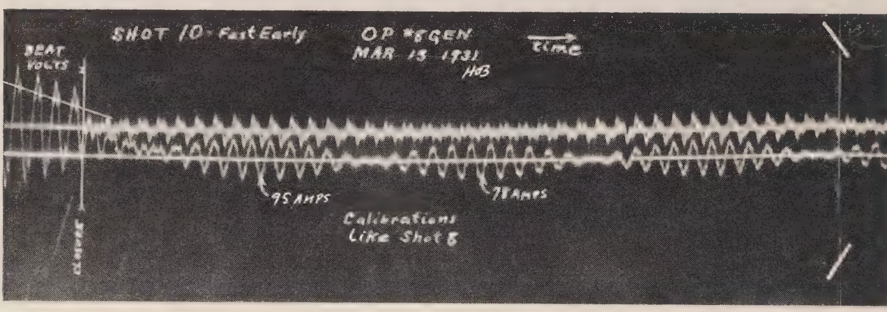
Oscillograms

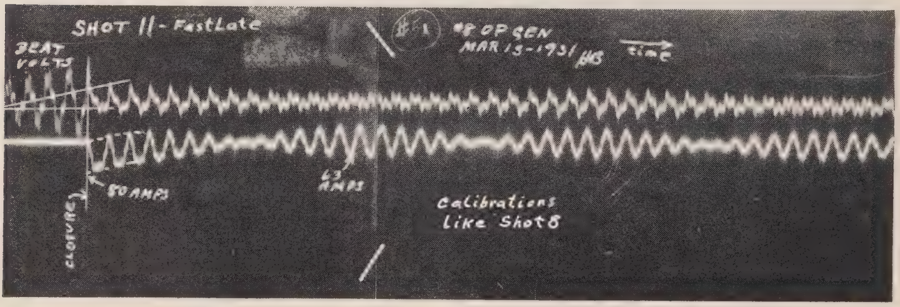


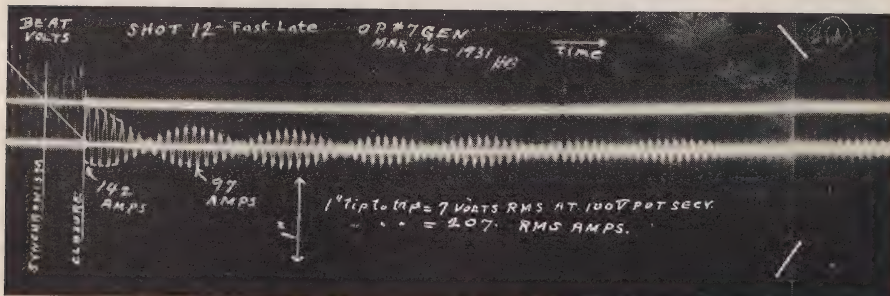


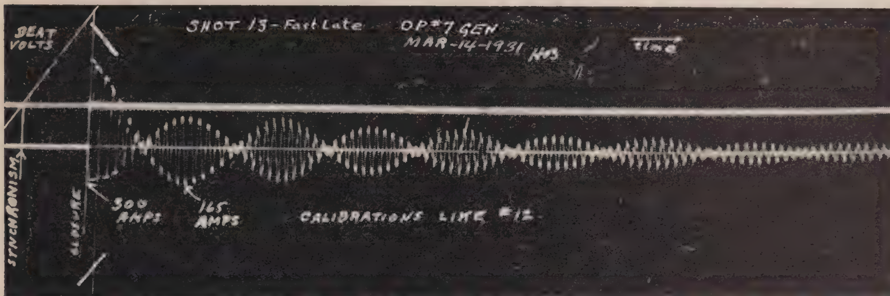


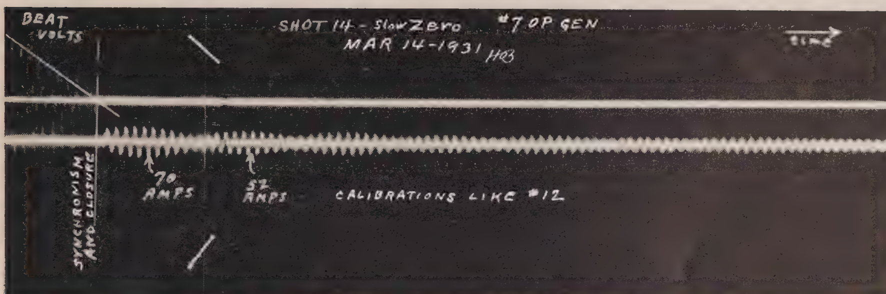

BEAT VOLTS
SHOT 9 - Slow Late
#8 OP GEN
MAR 13 1931 HB
time
210 AMPS
Calibrations like shot 8
CLOSURE
262 AMPS

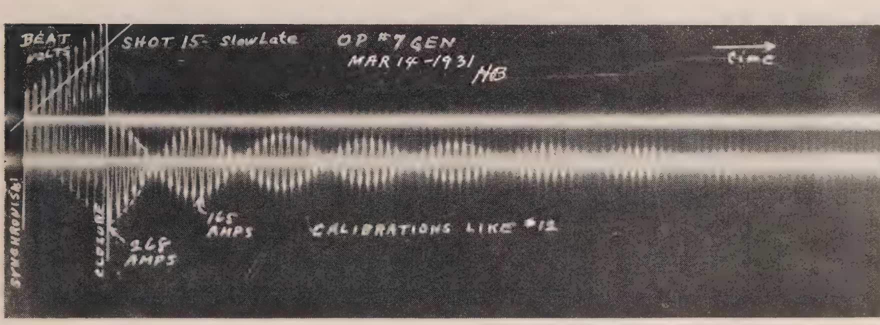

SHOT 10 - Fast Early
OP #8 GEN
MAR 13 1931 HB
time
BEAT VOLTS
95 AMPS
78 AMPS
Calibrations Like Shot 8
CLOSURE

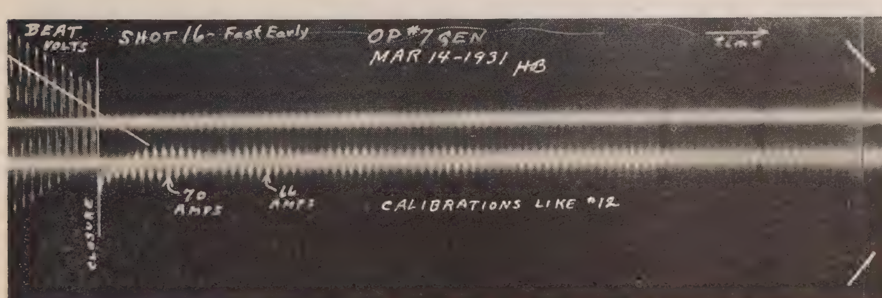

SHOT 11 - Fast Late
#8 OP GEN
MAR 13-1931 HB
time
BEAT VOLTS
80 AMPS
63 AMPS
Calibrations like Shot 8
CLOSURE

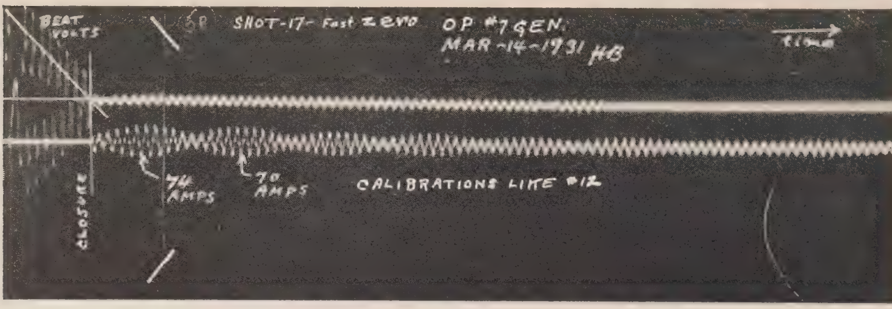

BEAT VOLTS
SHOT 12 - Fast Late
OP #7 GEN
MAR 14 - 1931 HB
time
SYNCHRONISM
CLOSURE
142 AMPS
97 AMPS
1" tip to tip = 7 VOLTS RMS AT 100V POT SEC'Y.
" " " = 207 RMS AMPS.

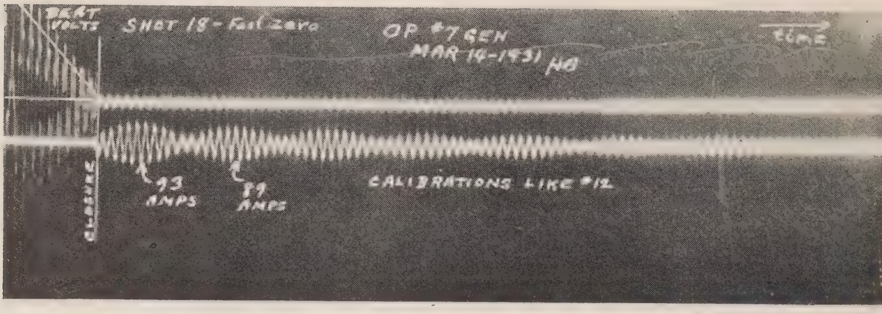

BEAT VOLTS
SHOT 13 - Fast Late
OP #7 GEN
MAR-14-1931 HB
time
SYNCHRONISM
CLOSURE
300 AMPS
165 AMPS
CALIBRATIONS LIKE #12

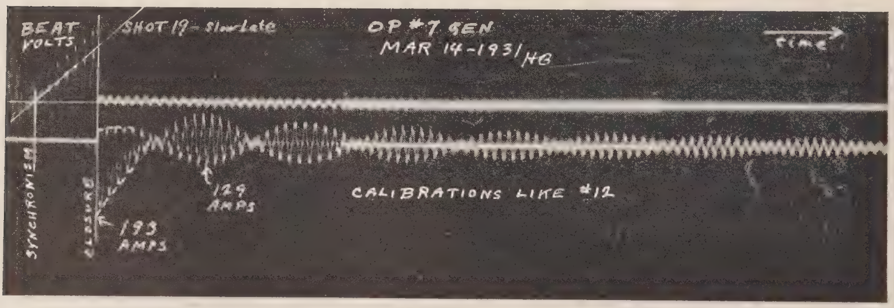

BEAT VOLTS
SHOT 14 - Slow Zero
#7 OP GEN
MAR 14-1931 HB
time
SYNCHRONISM AND CLOSURE
70 AMPS
57 AMPS
CALIBRATIONS LIKE #12

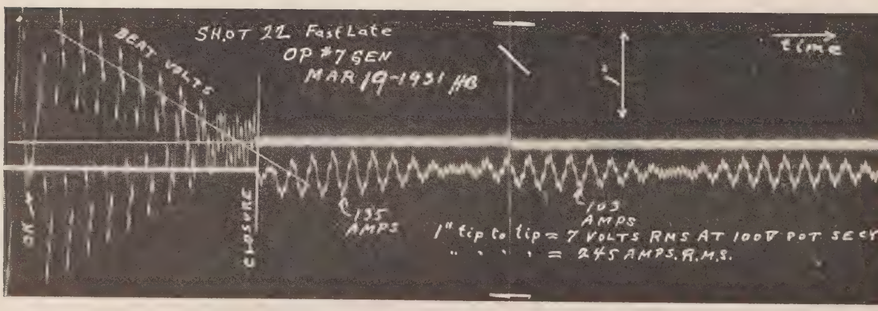

BEAT VOLTS
SHOT 15 - Slow Late
OP #7 GEN
MAR 14-1931 HB
time
SYNCHRONISM
CLOSURE
165 AMPS
268 AMPS
CALIBRATIONS LIKE #12

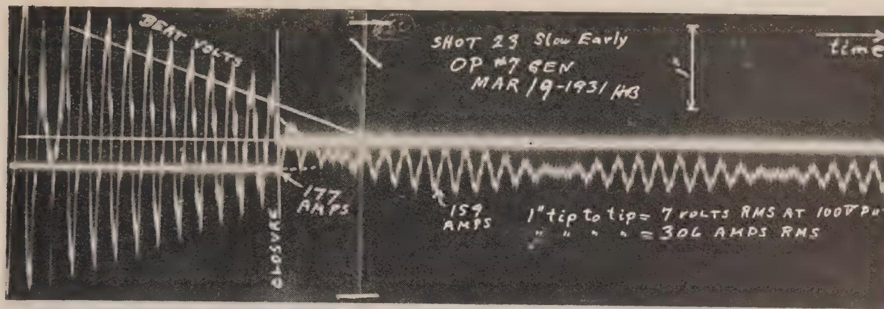

BEAT VOLTS
SHOT 16 - Fast Early
OP #7 GEN
MAR 14-1931 HB
time
CLOSURE
70 AMPS
66 AMPS
CALIBRATIONS LIKE #12

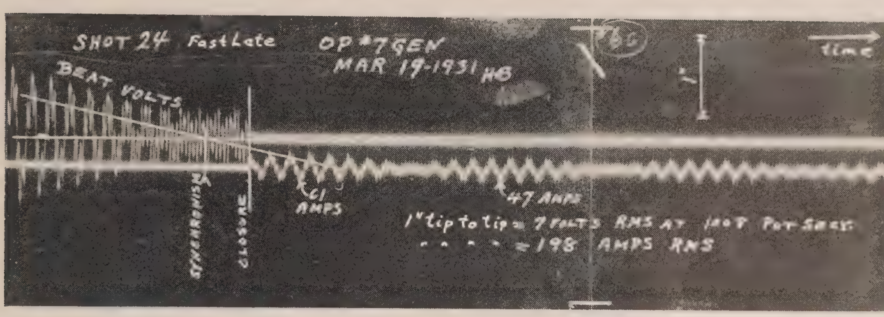

BEAT VOLTS
SHOT-17- Fast zero
OP #7 GEN.
MAR-14-1931 HB
time
74 AMPS
70 AMPS
CALIBRATIONS LIKE #12
CLOSURE

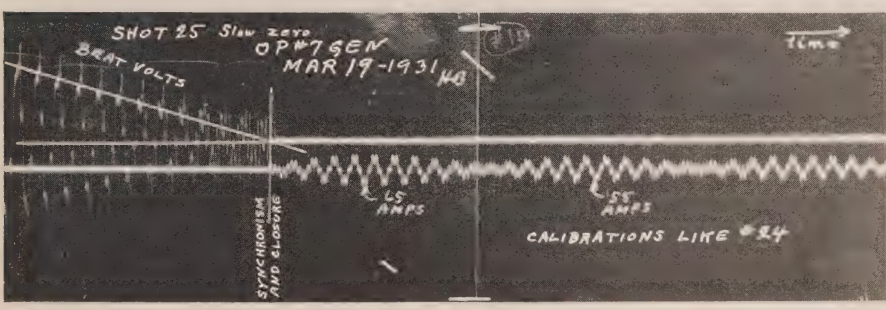

BEAT VOLTS
SHOT 18 - Fast zero
OP #7 GEN
MAR 14-1931 HB
time
93 AMPS
89 AMPS
CALIBRATIONS LIKE #12
CLOSURE

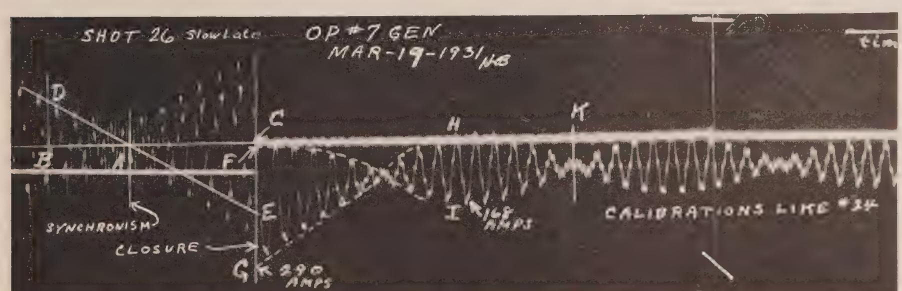

BEAT VOLTS
SHOT 19 - Slow Late
OP #7 GEN
MAR 14-1931 HB
time
129 AMPS
CALIBRATIONS LIKE #12
193 AMPS
SYNCHRONISM
CLOSURE

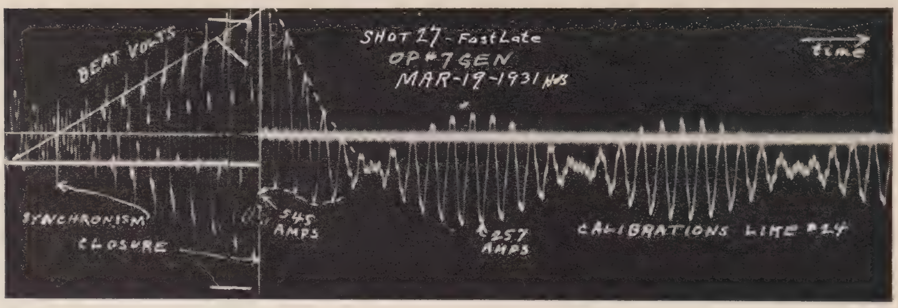

BEAT VOLTS
SHOT 22 Fast Late
OP #7 GEN
MAR 19-1931 HB
time
135 AMPS
103 AMPS
1" tip to tip = 7 VOLTS RMS AT 100V POT SEC
" " " " = 245 AMPS. R.M.S.
CLOSURE

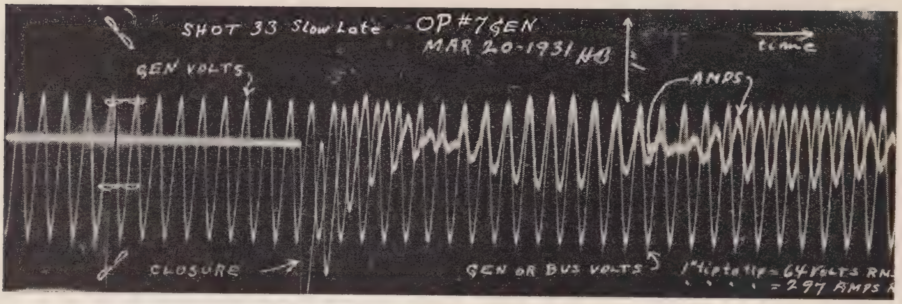

SHOT 23 Slow Early
OP #7 GEN
MAR 19-1931 HB
time
BEAT VOLTS
CLOSURE
177 AMPS
159 AMPS
1" tip to tip = 7 VOLTS RMS AT 100V
" " " " = 306 AMPS RMS

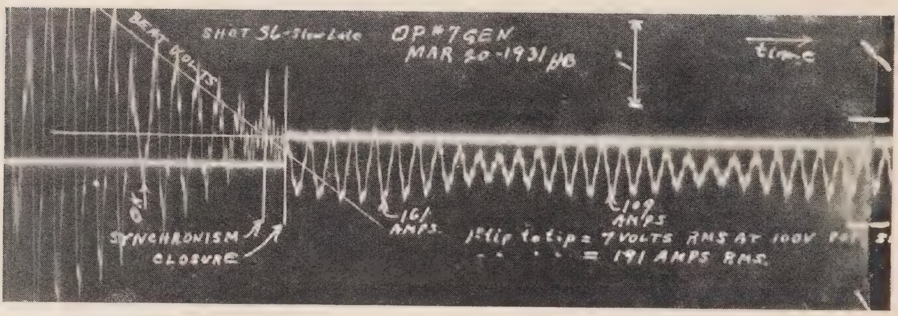

SHOT 24 Fast Late
OP #7 GEN
MAR 19-1931 HB
time
BEAT VOLTS
SYNCHRONISM
CLOSURE
61 AMPS
47 AMPS
1" tip to tip = 7 VOLTS RMS AT 100V Pot Sec.
" " " " = 198 AMPS RMS

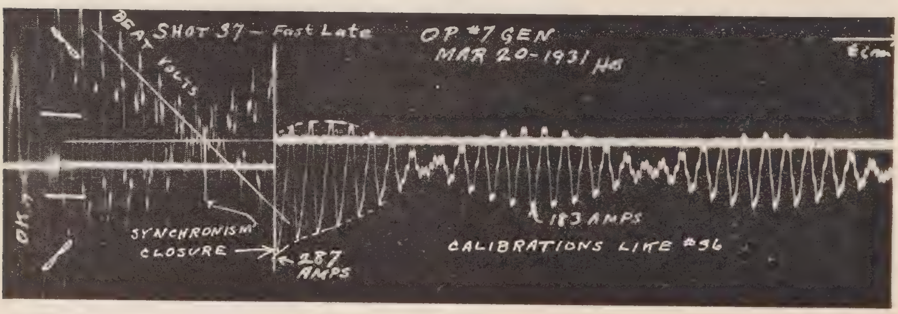

SHOT 25 Slow zero
OP #7 GEN
MAR 19-1931 HB
time
BEAT VOLTS
SYNCHRONISM AND CLOSURE
65 AMPS
55 AMPS
CALIBRATIONS LIKE #24


SHOT 26 Slow Late
OP #7 GEN
MAR-19-1931 HB
D
B
A
F
C
E
G
H
I
K
SYNCHRONISM
CLOSURE
290 AMPS
168 AMPS
CALIBRATIONS LIKE #24


SHOT 27 - Fast Late
OP #7 GEN
MAR-19-1931
time
BEAT VOLTS
SYNCHRONISM
CLOSURE
545 AMPS
257 AMPS
CALIBRATIONS LIKE #24


SHOT 33 Slow Late
OP #7 GEN
MAR 20-1931
time
GEN VOLTS
AMPS
CLOSURE
GEN OR BUS VOLTS
= 297 AMPS


SHOT 36 - Slow Late
OP #7 GEN
MAR 20-1931
time
BEAT VOLTS
SYNCHRONISM
CLOSURE
161 AMPS
109 AMPS
= 191 AMPS RMS.


SHOT 37 — Fast Late
OP #7 GEN
MAR 20-1931
BEAT VOLTS
SYNCHRONISM
CLOSURE
287 AMPS
183 AMPS
CALIBRATIONS LIKE #36

Hazards of Low Voltage

By W. P. Dobson, Chief Testing Engineer, H. E. P. C. of Ont.

AN article which appeared in "Industrial and Engineering Chemistry", calling attention to the hazards of low voltage and containing suggestions for the necessary precautions to reduce these hazards is reproduced herein.

The statistics given in the article were prepared by the National Safety Council and can therefore be accepted as authoritative and should be given the widest possible circulation in order that the erroneous impression that no danger need be feared from 110 volts circuits under any conditions, may be corrected.

One of the objects of the regulations respecting electric wiring and apparatus is to protect the public from injury, and I believe that the record in Ontario is very creditable and is evidence that the requirements of the Commission are being satisfactorily enforced and are, in general, adequate to protect the users of electricity. It is a fact, however, that many people do not realize the necessity for a few simple precautions: even though methods of construction may be perfect and inspection most efficient the disregard of elementary precautions on the part of the user will tend to nullify the efforts of the inspection authorities. It should be realized by the public that electrical apparatus of any particular type is designed for a specific purpose and is not intended to be used under conditions foreign to that purpose. The improper use of flexible cord mentioned in the attached article, is an example. There are many types of cord, each of which is approved for a certain use, and if it is used in a manner not intended it may be a source of danger. For example, a cord approved for a portable electric lamp has very thin insulation and should not be used for a washing machine where it is subject to considerable abrasion and to moisture.

There are a few important precautions which cannot be emphasized unduly. Among these may be mentioned:

1. Be very careful when you are in a damp place not to touch metal parts connected with electrical appliances. The rules of the Commission provide adequately for safety under such conditions. For example, only a porcelain fitting shall be used in basements, bathrooms, or other damp locations, and appliances are required to be supplied with proper approved connecting cords.

2. Under no condition use portable heaters in bathrooms. This use has been responsible for several deaths in Ontario in past years and is recognized in the Commission's rules which forbid the use of portable devices in bathrooms and also the use of key sockets. The lighting of a bathroom must be controlled by a wall switch adequately protected.

3. Do not use portable cords under rugs or tacked on baseboards for the purpose of extending lighting circuits. The only safe way is to install additional base receptacles or other outlets.

The Commission's Inspection Department and Approvals Laboratory exercise continual vigilance in examining electrical installations and electrical equipment in order to safeguard the public in the use of electricity. These safety measures must be seconded by intelligent use by the public of their electrical apparatus.

The article is as follows,—

"While those who work with high voltage fully recognize the dangers and take necessary precautions, in general there is a feeling that a voltage of from 110 to 750 volts is not particularly dangerous. The National Safety Council calls attention to the fact that more than one hundred fatal cases from contact with so-called low voltage electric current have occurred in the United States and Canada during the past two years. While this number is small compared with accidental deaths in other fields, it serves to emphasize the dangers of low voltage which too generally are underestimated.

"The council reports that more than 40 per cent. of the one hundred and seven cases studied were caused by the ordinary 110 alternating current voltage. Fifty-eight fatalities occurred in industry, nine in mines, and four on railways. Home fatalities came next to industry, totalling thirty-one deaths, and in this domestic list are to be found twelve bathtub deaths. Next in importance came fatalities from contact while on wet earth or basements. These totalled seven. Portable home appliances caused six deaths and amateur experiments may be charged with one fatality. Portable electric lamps under cellarless houses caused several of the casualities. Defective insulation on connecting cords handled with wet hands is the common defect which causes these deaths. Electric heaters, curling irons, and many other appliances at approximately 110 volts can cause these disasters under conditions too often prevalent. Many of the installations are reported as not in accordance with standard practice as represented by the National Electric Code."

The report serves to emphasize the necessity of using proper types of extension cords and their careful inspection to insure adequate insulation. Waterproof sockets, proper grounding of portable devices when used in damp locations and similar precautions are relatively simple. Scientists should know well the wisdom of killing circuits at all times before attempting to work with them. This is habitually done where high voltages are concerned. Now the Safety Council properly dwells on the importance of equal care in handling low voltages with which nearly all workers come in contact, not only in the plant, but in the laboratory and in the home.

Hydro News Items

Eastern System

The street lighting on King Street, Bowmanville, has been rebuilt and improved by the installation of larger units.

* * * *

Local committees are working on the promotion of rural lines to Miners Bay and Kinmount in the Fenelon Falls, R.P.D.

* * * *

The municipality of Peterboro is considering the building of a new 44,000 volt line from Auburn station to the municipal sub-station.

* * * *

The power line from Norwood sub-station to Hastings was completed and put in service on May 25th. Work has not been completed in the town as yet but the consumers are being cut-over to Hydro power as quickly as possible.

* * * *

Work instructions have been issued for the construction of two rural lines in Nepean district, one fifteen miles in length to serve the village of Vars and the other, eighteen miles in length, serving the villages of Metcalfe and Vernon.

* * * *

Mr. R. L. Dobbin, General Manager of the Public Utilities Commission of Peterboro, was elected President of the American Water Works Association Convention at Pittsburgh on May 25th. It is understood that Mr. Dobbin is the second Canadian to be so honored and we wish to extend to Mr. Dobbin our heartiest congratulations.

* * * *

Due to subnormal precipitation during the fall and winter months, the spring run-off or freshet on the eastern Ontario river watersheds, has been decidedly limited with the result that the storage available to assist in maintaining normal stream flow during the summer is considerably below the average.

A study of storage conditions for the month of May showed that, unless abnormal precipitation occurred during the ensuing months, power shortages might be experienced in the Central Ontario and Rideau districts. To obviate the possibility of such shortages it has been decided to change the operating voltage of the high tension line between Smiths Falls and Kingston from 44 kv. to 110 kv., the line having been insulated for the latter voltage at the time of its erection. This increase in voltage will effect a considerable reduction in line losses and will also enable more power to be fed into the Central Ontario district from eastern sources by increasing the capacity and the operating stability of this interconnection.

Before the above change in operating voltage can be effected it is necessary to construct a step down transformer station at the northerly limits of the City of Kingston. This station, which will have a capacity of 15,000 kv-a., is now in course of erection and it is anticipated that it will be ready for service early in July of this year. To provide transformers of the desired capacity on such short notice, three of the 5,000 kv-a. units now in service at Smith's Falls T.S. will be moved to Kingston and as a temporary arrangement a bank having a total capacity of 7,500 kv-a. will be made up at Smith's Falls T.S. using spare units which are available on the system.

The proposed change in operating voltage of the line between Smith's Falls and Kingston has also necessitated that special provision be made to take care of the load supplied from Forfar D.S. This is at present a single-phase station of 100 kv-a. capacity which taps the main line at a point approximately 19 miles from Smith's Falls. Owing to its location it has been found economical to replace the existing 44 kv. station with a 110 kv. step-down station of 400 kv-a. capacity. This type of station is an innovation in so far as the Commission's systems are concerned and is regarded as an experimental installation.

The Brook

(Collaboration by a poet and an engineer)

I come from haunts of coot and hern,
  I make a sudden sally,
And sparkle out among the fern
  To bicker down a valley.

But long before I reach the sea
  I'll prove my worth and power,
And engineers shall measure me
  In kilowatts per hour.

I wind about and in and out
  With here a blossom sailing,
And here and there a lusty trout
  And here and there a grayling.

But at the foot of yonder hill,
  A dam for a deterrent,
I'll pause and run a flour mill
  With my unresting current.

I steal by lawns and grassy plots
  I slide by hazel covers,
I move the sweet forget-me-nots
  That grow for happy lovers.

And when the ground is hard and dry,
  And summer days grow hotter,
I'll be diverted to supply
  Some extra city water.

I murmur under moon and stars
  In brambly wildernesses,
I linger by my shingly bars
  I loiter 'round my cresses.

Then out again I curve and flow
  With resolute endeavor,
For men may come and men may go
  But I toil on forever.

—New York Times.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Chairman, The Honorable J. R. Cooke's Letter of Submittal of the Twenty-third Annual Report.

To His Honour THE HONOURABLE WILLIAM D. ROSS, *Lieutenant-Governor of Ontario.*

MAY IT PLEASE YOUR HONOUR:

The undersigned has the honour to present to your Honour the Twenty-third Annual Report of The Hydro-Electric Power Commission of Ontario for the fiscal year ending October 31, 1930.

This Report covers all of the Commission's activities and also embodies the financial statements for the calendar year 1930, of the municipal electric utilities operating in conjunction with the various systems of the Commission and supplying electrical service to the citizens of the Province.

Dealing, as it does, with a multiplicity of activities relating to several electrical systems obtaining power from thirty-seven hydro-electrical plants operated by the Commission, supplemented by power purchased from other sources, and recording financial and other data relating to the individual local muncipal electric utilities, the Annual Report presents a large amount of statistical information, much of which must, of necessity, be of a summary character.

The financial statements, the statistical data and the general information given, however, are so arranged and presented as to give a comprehensive survey of the Commission's operations. Not only does the Report record the progress made during the past year, but it gives, in addition, certain cumulative results for the various periods during which operation has been maintained in the respective municipalities.

At the end of the fiscal year the number of municipalities served in Ontario by the Commission was 668. This number included 26 cities, 94 towns, 251 villages and police villages and 297 townships. With the exception of 12 suburban sections of townships known as voted areas, the townships and 79 of the smaller villages are served as parts of 160 rural power districts.

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July, 1931

During the year, the Commission purchased the properties of the Dominion Power and Transmission Company, Limited, for the sum of $21,000,000. The capacity of the generating plants and contracts for power purchased amount to 83,900 horse power. Power is delivered to a large number of municipalities and industrial consumers in the territory extending from Port Colborne and St. Catharines to Hamilton, Brantford and Oakville.

Constructional Activities

The chief constructional activities of the Commission during the past year comprised the putting into service of the tenth unit at Queenston generating station on the Niagara river, the virtual completion of the Alexander power development on the Nipigon river, substantial progress of the Chats Falls development on the Ottawa river, the completion of the second 220,000-volt circuit on separate towers of the transmission line conveying Gatineau power from the Ottawa river to Leaside, Toronto, the addition of transformer capacity to many transforming and distributing stations, and the construction of no less than 1,890 additional miles of primary lines in rural power districts.

The tenth generator at Queenston came into service in July, 1930, and the temporary bulkheads and walls at the north end of the generating station were replaced by permanent structures. It is interesting to note that the hydraulic equipment and the general design of the plant are essentially the same for the tenth as for the first unit. No important advances have taken place in plant design for hydraulic units of the head and capicity of those at Queenston, and therefore the original portions of the plant, although in service for nine years, are not in any degree obsolete.

The virtual completion of the Alexander power development in October and the placing in service of the first generating unit, followed a season in which construction work was carried on very rapidly in order to take full advantage of the favourable weather during the summer months for the building of the main dam, which is a semi-hydraulic earth fill. This is the first dam of this type built by the Commission. The growth in load in the Thunder Bay system has been striking. It will be remembered that not many years ago doubt was expressed as to the possibility of the then partial development at Cameron Falls finding sufficient load to justify its construction. The load demands have been such as to necessitate the completion of the Cameron Falls development and the addition of the new Alexander

development. Further studies and surveys are being made of the undeveloped head on the Nipigon river between Cameron Falls and lake Nipigon.

Rapid progress is being made in the design and construction of the new development at Chats Falls on the Ottawa river. When completed, 192,000 horsepower will be available at this site for the Commission's requirements.

The second link between the Gatineau river plants and the Niagara system at Leaside-Toronto has been made by the completion of the second 220,000-volt circuit. This double-circuit line, now in operation, provides sufficient transmission capacity to deliver all the power required at present from the east, for the Niagara system. Additional equipment at Toronto-Leaside transformer station has been installed, including the third and fourth banks of 15,000-kv-a. transformers. A 220,000-volt transformer station is being constructed at Chats Falls in connection with the development at that site.

The regular growth in load necessitates each year a substantial increase in the transformer capacity in the various systems and the past year has been no exception. Seven 10,000-kv-a. transformers were purchased to replace 5,000 kv-a. units in some of the 110,000-volt stations of the Niagara system. In the Georgian Bay system a 5,000-kv-a. frequency-changer set was installed at Hanover to permit further interchange of power between this and the Niagara system.

Operating Conditions

The customary high standard in the operation of the systems has been maintained throughout the year and the general service has been satisfactory and free from major failures of equipment. The extensive interconnection of transmission networks has continued to exert its beneficial effects in the economy of operation and continuity of service. Further progress has been made in the advantageous programme of interconnection and consolidation.

Notwithstanding the prevailing industrial depression, the total load supplied by the Commission with respect to the territory reported upon in the last year's Report, has increased. In addition, there is recorded for 1930 a further increase in the loads supplied as a result of the inclusion in this year's Report of the loads of the undertakings and companies purchased from the Dominion Power and Transmission Company, Limited, and the Bruce County service. It is appropriate to recall the fact that the 1929 increase in load over the previous year's total was exceptionally large.

During the past year the output of the Commission's generating plants in the central and eastern parts of the Province was curtailed due to deficient stream flow resulting from subnormal precipitation. However, as a result of the interconnections made during recent years and the provisions for purchased power no restrictions of service were necessary in the Georgian Bay and Eastern Ontario systems. In the Nipissing district of the Northern Ontario

system where interconnection with other districts is not yet provided, some restriction of load was unavoidable during December, 1929, and January, 1930, until a thaw gave relief. In the Sudbury district a flood in June caused a brief restriction of service. With these relatively minor exceptions, ample supplies of power have been continuously available in all systems.

COST OF ELECTRICAL SERVICE FURNISHED BY THE COMMISSION

The function of the Commission is not only to use its best endeavours to provide for the people of Ontario an adequate and reliable supply of electrical energy, but also to ensure that the cost of that electrical energy to the consumers shall be the minimum consistent with the financial stability of the enterprise. The success that has been attained in the accomplishment of the latter object may be appreciated by a careful study of the statistical data relating to the supply of electrical energy to consumers as given in Statement "D" and the actual rates to consumers as presented in Statement "E" in conjunction with the various financial statements of the Report.

GROWTH IN LOAD

The following tabulation (Table No. 1) shows the growth in load in the various systems during the year.

FINANCIAL SUMMARIES

It will be observed that the financial statements embodied in this Report are presented in two main divisions, namely, a division—Section IX—which deals chiefly with the operations of the Commission in the generation, transformation and transmission of electrical energy to the co-operating municipalities; and a division—Section X— which deals with the various operations of the municipal electric utilities in the localized distribution of electrical energy to consumers. In Section IX, "Rural Operating" reports are also

TABLE NO. 1

DISTRIBUTION OF POWER TO SYSTEMS

20-MINUTE PEAK HORSEPOWER SYSTEM COINCIDENT PEAKS

System	October 1929	December 1929	October 1930	December 1930
Niagara system	949,732	970,509	1,000,670	1,028,400
Dominion Power & Trans. system	....	....	58,579	61,528
Georgian Bay system	22,118	22,961	23,355	25,591
Eastern Ontario system*	82,299	90,800	88,678	93,560
Thunder Bay system	77,117	64,588	73,968	61,300
Northern Ontario system:				
Nipissing district	3,599	3,492	3,745	3,654
Sudbury district	10,657	11,394	12,935	10,724
Patricia district	....	....	1,582	1,521
Total	1,145,522	1,163,744	1,263,512	1,286,278

*"Eastern Ontario System" includes Central Ontario, St. Lawrence, Rideau, Ottawa and Madawaska districts.

given, which summarize the results of the local distribution of rural electrical service by the Commission to the individual consumers in rural power districts. This work is performed by the Commission on behalf of the respective townships co-operating to provide rural service.

The cumulative results of the operation of the several systems of the Commission as set forth in this Report demonstrate a sound financial condition.

The total investment of the Hydro-Electric Power Commission of Ontario in power undertakings and hydro-electric railways is $260,593,779.36, and the investment of the municipalities in distributing systems and other assets is $99,054,262.47, making in power and hydro-electric railway undertakings a total investment of $359,648,041.83.

Capital Investment

The following statement (Table No. 2) shows the capital invested in the respective systems and municipal undertakings.

Revenue of Commission

The Commission collected from the municipal utilities and other customers, a total sum of $28,555,998.47. This sum was appropriated to meet all the necessary fixed charges and to provide for the expenses of operation and administration. After meeting all charges there was left a net surplus of $1,262,456.60.

The following statement (Table No. 3) summarizes the Commission's collections from municipal electric utilities and other power customers for the year and shows how the collections have been appropriated.

Rural Electrical Service

During the past few years very substantial progress has been made in Ontario in the field of rural electrification. Practically all rural electrical service is now given through rural power districts which are operated directly by the Commission. There is now rather more than $12,665,000 invested in the rural power district systems established by the Commission. Towards this rural

TABLE NO. 2

Niagara system	$176,172,587.76
Dominion Power & Transmission Co. and Subsidiaries	21,489,434.83
Chats Falls development	2,137,230.18
Georgian Bay system	7,940,666.96
Eastern Ontario system (including Madawaska, Ottawa and Nipissing districts)	20,917,182.90
Thunder Bay system	17,645,796.31
Northern Ontario system—(Sudbury and Patricia districts)	3,297,543.10
Hydro-electric railways	7,340,565.05
Office and service buildings, construction plant, inventories, etc.	3,652,772.27
	$260,593,779.36
Municipalities' distributing systems and other assets (exclusive of $17,346,372.44 of municipal sinking fund equity in H.E.P.C. system)—all systems	99,054,262.47
	$359,648,041.83

TABLE NO. 3

Revenue from municipal electric utilities and other power customers		$28,555,998.47
Appropriated as follows:		
Operation, maintenance, administration, interest and other current expenses	$19,772,039.08	
Reserves for sinking fund, renewals, contingencies and obsolescence provided in the year	7,521,502.79	
		27,293,541.87
Net surplus credited to municipalities under cost contracts		$1,262,456.60

NOTE.—The above figures do not include the revenue from the operation of the undertakings and companies which were acquired by the Commission from the Dominion Power and Transmission Company, Limited, as from January 1st, 1930. From this date the Commission has continued the operation thereof under the various company franchises, and a separate revenue and expense statement is shown for these.

work the Ontario Government, pursuant to its policy of promoting the basic industry of agriculture, has, in the form of grants-in-aid, contributed 50 per cent. of the costs of transmission lines and equipment, or some $6,300,000. A total of 6,726 miles of transmission lines have been constructed to date, of which 1,891 miles were constructed during the past year, a mileage which exceeds that constructed in any former year. There are now more than 46,000 customers supplied in the rural power districts.

TABLE NO. 4

RURAL POWER DISTRICTS—OPERATIONS FOR YEAR 1930

	Niagara system	Georgian Bay system	Eastern Ontario system	Totals
	$ c.	$ c.	$ c.	$ c.
Cost of power as provided to be paid under Power Commission Act	615,089.29	48,685.64	97,793.94	761,568.87
Cost of operation, maintenance and administration	408,419.77	23,704.25	66,035.16	498,159.18
Interest	186,962.86	14,705.71	31,997.23	233,665.80
Renewals	167,463.56	11,844.29	27,611.10	206,918.95
Obsolescence and contingencies	83,731.78	11,844.29	13,805.55	109,381.62
Sinking Fund	44,370.01	3,368.40	7,390.49	55,128.90
Total expenses	1,506,037.27	114,152.58	244,633.47	1,864,823.32
Revenue from customers	1,628,018.20	109,933.71	260,299.70	1,998,251.61
Surplus	121,980.93		15,666.23	137,647.16
Deficit		4,218.87		4,218.87
Net surplus				133,428.29

Municipal Electric Utilities

The following (Table No. 5) is a summation of the year's operation of the local electric utilities conducted by municipalities receiving power under cost contracts with the Commission.

Reserves of Commission and Municipal Electric Utilities

The total reserves of the Commission and the municipal electric utilities for sinking fund, renewals, contingencies and insurance purposes amount to $103,857,683.12, made up as follows (Table No. 6).

The consolidated balance sheet of the municipal electric utilities, on page 261, shows a total cash balance of $2,722,250.12, and bonds and other investments of $1,909,439.11. The total surplus in the municipal books now amounts to $34,452,790.22 in addition to depreciation and sundry other reserves aggregating $14,460,-043.25.

The following is a brief summary of the principal operations relating to the several systems of the Commission.

Niagara System

The Niagara system embraces all the territory lying between Niagara Falls, Hamilton, and Toronto on the east, and Windsor, Sarnia, and Goderich on the west, served with electrical energy generated at plants on the Niagara river, supplemented with purchased power transmitted from the Gatineau river.

There has been a steady increase in the number of consumers in this district and also in the load supplied

TABLE NO. 5

Total revenue collected by the municipal electric utilities		$30,241,820.19
Cost of power	$17,323,077.97	
Operation, maintenance and administration	5,394,779.96	
Debenture charges and interest	4,028,276.07	
Depreciation	1,574,991.68	
Total		28,341,125.68
Surplus		$1,900,694.51

TABLE NO. 6

Niagara system	$ 43,069,032.12
Georgian Bay system	1,889,781.64
Eastern Ontario system	4,123,718.36
Thunder Bay system	2,165,992.31
Northern Ontario system	10,582.50
Bonnechere storage	19,234.16
Service buildings and equipment	570,210.27
Hydro-electric railways	102,951.70
Insurance, workmen's compensation and staff pension insurance	2,993,346.59
Total reserves of the Commission	$54,944,849.65
Total reserves of municipal electric utilities	48,912,833.47
Total Commission and municipal reserves	$103,857,683.12

by the Commission to the municipalities. Power supplied to the Commission by the Gatineau Power Company is received by the Commission at the interprovincial boundary on the Ottawa river and is transmitted over two 220,000-volt, steel-tower transmission lines to Leaside. The construction of the second circuit, on separate steel towers, was completed during the year and put into operation in order to assist in carrying the heavy winter load. A third circuit line from Leaside to Chats Falls is under construction.

The arrangements already made will ensure for this system an adequate supply of power for a number of years ahead. In addition to the contracts for Gatineau river power, the Commission has entered into an agreement with the Chats Falls Power Company for the joint construction of a plant at Chats Falls on the Ottawa river having a capacity of 216,000 horsepower, the Commission is to purchase the Company's half of this power for a term of years. Power amounting to 250,000 horsepower developed on the St. Lawrence river will also be purchased from the Beauharnois Light, Heat and Power Company, and 125,000 horsepower to be delivered to the Commission as required from a plant on the Lievre River is contracted for from the James MacLaren Company, Limited.

The tenth unit in the Queenston generating plant, which was arranged for in 1928, was placed in operation on July 4, 1930, and is available to assist in taking care of the winter load for 1930-31.

The purchase of undertakings and companies from the Dominion Power and Transmission Company, Limited, has already been referred to. Since their acquisition by the Commission the operation of these properties has been continued by the same staff and on the same basis. The co-ordination of this system with the Niagara system will be carried out as may be found to be to the mutual advantage of both.

The total capital invested by the Commission on behalf of the co-operating municipalities of the Niagara system is $176,172,587.76, and the accumulated reserves for renewals, obsolescence, contingencies and sinking fund, aggregate $43,069,-032.12. This is exclusive of the undertakings and companies purchased from the Dominion Power and Transmission Company, Limited, for which separate statements of assets and liabilities, and operations are presented.

From the rural power districts of this system, which are directly operated by the Commission, the revenue received for the year from customers was $1,628,018.20, and the total cost of supplying the service was $1,506,037.27, leaving a balance of $121,980.93, which is placed to the credit of the districts in this system. The greater part of this surplus is returnable to the users in the form of reduced rates.

With respect to the electric utilities of the various municipalities of the Niagara system, the actual cost of power during the year was $827,-049.01 less than the total amount collected at the interim rates, and this sum has been credited to the Municipal Utilities. The total net surplus for the year from the operation

of the various municipal electric utilities was $1,215,442.02, after providing $1,342,130.60 for depreciation and $1,643,661.24 for the retirement of instalment and sinking fund debentures.

Nine municipal utilities had small deficits upon the year's operations, aggregating $1,886.09, whereas the total combined surplus of the other municipal electric utilities served by this system was $2,559,458.71. The total revenue of the municipal electric utilities served by this system was $24,831,168.71, an increase of $655,292.70.

GEORGIAN BAY SYSTEM

The Georgian Bay system comprises the area which includes the counties of Bruce, Grey, Dufferin, and Simcoe, and the northern portions of Huron, Wellington, and Ontario, also a large portion of the district of Muskoka, all of which areas are adjacent to Georgian Bay.

Electrical energy is obtained from two developments on the Severn river, one on the Beaver river, and three on the Muskoka river, also from two frequency changer stations tied in with the Niagara system. The total capacity of this system exceeds 30,000 horse power and all of the developments are tied together through a network of transmission lines. The 5,000-kv-a. frequency-changer set situated at Hanover was completed and placed in operation during the year. Power is delivered from the Niagara system at Kitchener over a 110,000-volt transmission line.

During the year, negotiations were completed with the Public Utilities Consolidated Corporation of Minneapolis, Minnesota, for the purchase of what is known as the "Foshay" interests in Bruce county, covering the Saugeen Electric Light and Power Company and the Walkerton Electric Light and Power Company. The Commission on behalf of the municipalities has assumed control and they now form part of the Georgian Bay system.

The village of Windermere entered into an agreement for a supply of power on the standard cost basis.

Notwithstanding the prevailing industrial depression, there was this year a considerable increase in the power sold throughout this system, due in part to a marked expansion in the rural districts.

The total capital invested by the Commission on behalf of the co-operating municipalities of the Georgian Bay system is $7,940,666.96, and the accumulated reserves for renewals, obsolescence, contingencies and sinking fund, aggregate $1,889,-476.03.

From the rural power districts of this system, which are directly operated by the Commission, the revenue received for the year from customers was $109,933.71, and the total cost of supplying the service was $114,152.58, leaving a balance of $4,218.87, which has been charged to the districts in this system.

With respect to the electric utilities of the various municipalities of the Georgian Bay system, the actual cost of power during the year was $20,-805.38 less than the total amount collected at the interim rates, and this has been credited to the municipal utilities. The total net surplus for the year from the operation of the

various municipal electric utilities was $40,419.66, after providing $54,452.40 for depreciation and $54,212.34 for the retirement of instalment and sinking fund debentures. Twelve municipal utilities had small deficits upon the year's operations, aggregating $13,337.99, whereas the total combined surplus of the other electric utilities served by this system was $53,757.65. The total revenue of the municipal electric utilities served by this system was $1,051,101.54, an increase of $6,465.06.

Eastern Ontario System

This system now serves the whole of that portion of Ontario east of the areas served by the Georgian Bay and Niagara systems. Consolidation of the Central Ontario and Trent systems with the St. Lawrence, Rideau and Ottawa systems, making up the Eastern Ontario system, was undertaken because of the necessary interchange of power supply and for other reasons which made it impracticable longer to operate these systems separately; final details for consolidation were completed during the year. The properties of the Galetta Electric Light & Power Company, and the Calabogie Power Company, known as the Madawaska system, have also been added to form part of this system.

During the year the Commission completed the purchase of the Beach Rural Electric System lines serving rural customers in the townships of Matilda, Williamsburg, Mountain, Winchester and South Gower, and with this purchase agreement an arrangement was made for the purchase of a supply of 500 horsepower from the Beach Estate at Iroquois, which power is consolidated with the Eastern Ontario system supplies and is used to supply the rural lines purchased from the Beach Rural Electric System, Limited.

The Commission disposed of the local distribution systems, forming part of the Central Ontario district properties in the towns of Brighton, Port Hope and Napanee. These properties were purchased by the respective municipalities and agreements were entered into for a supply of power on the standard cost basis. The municipalities of Madoc and Stirling whose fixed rate contracts for power expired December 31, 1929, also entered into agreements for power supply on the standard cost basis. The village of Cardinal also entered into an agreement for a supply of power from this system during the year.

The Ottawa district embraces the city of Ottawa, the village of Richmond, and the Nepean rural power district. The city of Ottawa "Hydro" system has continued the steady growth experienced in other years. There has also been much expansion in the rural district. During the year the city has received an augmented supply of power from the Commission through the new high-tension station constructed jointly by the Provincial Commission and the Ottawa Hydro Commission.

This power is taken at 110,000 volts from the supply made available under the contract with the Gatineau Power Company.

Reflecting the general industrial

depression the load requirements of the Eastern Ontario system were slightly lower than was anticipated. The normal yearly increment of 6,000 horse power under the contract with the Gatineau Power Company, together with power generated by the Commission has provided ample power for all the customers of this system.

The total capital invested by the Commission on behalf of the co-operating municipalities of the Eastern Ontario system is $20,917,182.90, and the accumulated reserves for renewals, obsolescence, contingencies and sinking fund aggregate $4,123,718.36.

From the rural power districts of this system, which are directly operated by the Commission, the revenue received for the year from customers was $260,299.70, and the total cost of supplying the service was $244,633.47, leaving a balance of $15,666.23, which is placed to the credit of the districts in this system. The greater part of this surplus is returnable to the users in the form of reduced rates.

With respect to the electric utilities of the various municipalities of the Eastern Ontario system, the actual cost of power during the year was $58,783.30 less than the total amount collected at the interim rates and this has been credited to the municipal utilities. The total net surplus for the year from the operation of the various municipal electric utilities was $373,651.95, after providing $143,712.83 for depreciation and $108,377.27 for the retirement of instalment and sinking fund debentures. Three municipal utilities had small deficits upon the year's operations, aggregating $1,727.35, whereas the total combined surplus of the other electric utilities served by this system was $375,379.30. The total revenue of the municipal electric utilities served by this system was $2,887,135.45, an increase of $385,102.53.

Thunder Bay System

The Thunder Bay system comprises that portion of the district of Thunder Bay adjacent to Lake Superior, and includes the lake-head cities of Port Arthur and Fort William, and the village of Nipigon. In addition to supplying electrical service in the three municipalities, power is supplied chiefly for grain elevators and pulp and paper mills. Due to industrial depression which has largely affected these two industries this system has not made as good a showing as it would have done had trade conditions been normal. In spite of this handicap, however, the showing for the year has been satisfactory.

The first unit of the new Alexander development, situated one and one-half miles below Cameron Falls, was placed in operation for the first time during the year, and the entire development is now about 98 per cent. complete. As soon as the other two units are completed and placed in operation an additional 54,000 horse power will be made available, which, together with the Cameron Falls development, will make available a total capacity of 129,000 horsepower for this system.

The Commission has, in the Thunder Bay system, a total investment of $17,645,796.31, and accumulated reserves for renewals,

contingencies, and sinking fund aggregate $2,165,992.31.

The total revenue collected by the Commission for power provided for the municipalities and sold to private companies connected to this system was $1,420,236.89, which exceeded the cost of power supplied by $2,665.87, which sum has been credited to the three municipalities operating under cost contracts in this district. The total revenue of the municipal electric utilities in this system was $1,472,414.49. The three municipalities served by this system operated with a net surplus of $271,180.88, after providing depreciation to the extent of $34,695.85 and $21,810.77 for the retirement of debentures.

Northern Ontario System

In this system are grouped three districts, at present independent, which serve portions of northern Ontario. The Nipissing district, formerly known as the Nipissing system, has been operated by the Commission for a number of years; the Sudbury district was formerly served by the Wahnapitae Power Company recently acquired by the Commission, and the Patricia district is a new district recently established.

Nipissing District

This district includes the city of North Bay, the town of Powassan, and the villages of Callander and Nipissing, all of which lie immediately east of lake Nipissing. Power is obtained from three hydro-electric developments on the South river, namely, Nipissing, Bingham Chute and Elliott Chute.

Sudbury District

This district comprises the southern portions of the district of Algoma, Sudbury, and Nipissing, and is at present supplied with power from three developments on the Wahnapitae river, recently purchased by the Commission from the Wahnapitae Power Company.

A special investigation was made covering the delivery of a large block of power to this district for the mining industry, and a contract was finally executed between the Ontario Power Service Corporation and the Commission, covering a supply of 100,000 horse power from a development at Abitibi Canyon on the Abitibi river about fifty miles north of Cochrane. The first delivery of this power will be made during the latter part of next year.

Patricia District

Power is served from a development at Ear Falls at the foot of Lac Seul, the present capacity of which is 5,000 horse power. Power was delivered for the first time during the year to The Howey Gold Mines Limited, which is the only customer in this district at the present time, but a large block of power is available for any mining or other industry desiring same, and it is expected that this development will prove to be of great service to the district.

The Annual Report

The Table of Contents, pages xxi and xxii, conveys a good understanding of the scope of the matters dealt with in the Report, to which there is also a comprehensive Index. To those not conversant with the

Commission's Reports the following notes will be useful.

In Section II, pages 6 to 55, dealing with the Operation of the Systems, are a number of interesting diagrams showing, graphically, the increase in the loads on the various systems. Tables are also presented showing the amounts of power taken by the various municipalities during the past three years.

The rural distribution work of the Commission has proved of widespread interest and special reference to this is made in Section III, on pages 64 to 79. The power distributed to rural districts is, and possibly must always be, but a relatively small proportion of the power distributed by the Commission. The supplying of electrical service in rural areas, and especially on the farm, has, however, been of great economic benefit to Ontario. The Provincial Government grants-in-aid to this work have been of value to agricultural activities, and have assisted the Commission to extend transmission lines to many areas.

In Section IV, V and VI will be found information respecting progress of work on new power developments and on transmission system extensions, together with photographic illustrations.

About three-fifths of the Report is devoted to statistical, financial data which are presented in two Sections, IX and X.

Section IX presents in summary form the financial statements relating to the operations of the Commission chiefly in the generation, transformation and transmission of electrical energy to the co-operating municipalities. It is introduced by an important explanatory statement which appears on pages 137 to 141, to which special reference should be made.

Section X presents in summary form the financial statements relating to the operations of the municipalities in the localized distribution of electrical energy to consumers. It also contains details of the costs of electrical energy to consumers in the various municipalities and tabular statements of the rates in force which have produced these costs. An explanation of the various tables and statements is given at the commencement of this Section on pages 255-257; and a special introduction to Statement "D," which relates to the cost of electrical service in Ontario, together with a diagram, appears on pages 366 to 369.

In its Annual Reports the Commission aims to present a comprehensive statement respecting the activities of the whole undertaking under its administration. Explanatory statements descriptive of the operations of the Commission in various branches of its work are suitably placed throughout the Report in order that the citizens of the Province may be kept fully informed upon the working-out of the Commission's policies.

* * * *

In conclusion, I should like to refer to the retirement from the Chairmanship of the Commission of Mr. Charles A. Magrath.

As may be recalled, Mr. Magrath was appointed to the Chairmanship on September 12, 1925, and his

retirement became effective on February 6, 1931.

During his tenure of office, Mr. Magrath in devoting himself to the general administrative work of the Commission gave special attention to strengthening the Commission's position with respect to its financial reserves, but perhaps the outstanding effort which he put forth was in connection with the provision for future supplies of electrical energy to meet the needs of Ontario municipalities. All sources of possible supply were reviewed. The production of additional hydro-electric power from water powers owned by the Province was most carefully considered and furthered wherever economically possible; definite attention was given to the desirability or otherwise of developing steam-electric power, and the possibilities of purchasing power in large blocks to be supplied from sites owned or controlled by private organizations were examined.

There are two main sources of power from international waters in which the Province possesses a definite but not a sole interest—the Niagara and the St. Lawrence rivers, and there is also the inter-provincial Ottawa river. Mr. Magrath's experience in connection with matters before the International Joint Commission acquainted him with the fact that programmes for the development or utilization of international waters have sometimes had to proceed much more slowly than might superficially have been expected from preliminary favourable circumstances. To the solving of problems arising in connection with efforts to expedite development of these power sources, Mr. Magrath brought special experience.

For more than ten years the problem of the development of the St. Lawrence river for navigation and power has been the subject of special investigation and effort by the two Federal Governments concerned, but as yet no plan of development has been finally determined upon and, consequently, the Commission has never received sufficient authority to enable it to proceed with the development of Ontario's share of the St. Lawrence river power. Moreover, the Commission had to reckon with the fact that the evidence of engineers has been that from five to eight years would be required to complete such a development as the St. Lawrence. Consequently, even were the St. Lawrence development commenced, constructional work and preliminaries incident thereto might occupy up to eight years before the Hydro-Electric Power Commission could reasonably hope to obtain its full share of St. Lawrence power, and therefore no hope for an early supply of power from this source could be entertained.

With respect to power at Niagara: In 1926, a Special International Niagara Board was appointed to determine how the erosion of Niagara Falls could be arrested, how the preservation of their scenic beauty could best be effected, and what, if any, waters additional to those allotted under the Boundary Waters Treaty of 1909-10 could be diverted either temporarily or permanently for further power development. Consequent upon the Report which this

Board made, a proposed Treaty was drawn up by representatives from both the countries concerned providing for an additional diversion of water for power from Niagara, but the proposed measure was rejected by the United States Senate in January, 1931. In view of the uncertainty respecting the outcome of these negotiations, the Commission was not justified in counting upon Niagara waters as a source of additional power supply in the near future.

With regard to the Ottawa river, until recently, the Hydro-Electric Power Commission was unable to proceed in Ontario because claims made under the Charter of the Georgian Bay Canal Company were not definitely cleared away until this Charter was terminated by Federal action in 1927.

Confronted with such circumstances and restrictions—the bearing of which upon the Commission's work was appreciated by no one more clearly than by Mr. Magrath—the Commission believed that the best means of providing adequate power supplies for the immediate future consisted in purchasing power in large blocks at the best prices possible. After comprehensive survey of the various possibilities, the Commission in 1926 and subsequent years consummated several contracts for purchased power. These purchases consist of 260,000 horsepower from the Gatineau Power Company; a further contract covering an additional 60,000 horsepower also from the Gatineau; 250,000 horsepower from the Beauharnois development being made in Quebec on the St. Lawrence river; 125,000 horsepower from the Maclaren development on the Lievre river, also in Quebec; 96,000 horsepower from the Quebec portion of the Chats Falls development on the Ottawa river; and 100,000 horsepower to be developed at the Abitibi Canyon on the Abitibi river in Ontario. The Commission will also have 96,000 horsepower from its own portion of the development at Chats Falls. These provisions for power, together with the output of the Commission's existing generating plants, will aggregate in all some 2,000,000 horsepower by 1937.

Throughout the important considerations involved in these transactions, Mr. Magrath's wide business experience, his foresight, and his care to ensure not only that the needs of the municipalities of Ontario were provided for, but also that the interests of the municipalities were safeguarded, were features which carried forward the Commission's policy under his Chairmanship, and will be remembered by his colleagues with gratitude.

The work covered by this Report was performed under the Chairmanship of Mr. Magrath and it affords me much pleasure on behalf of my fellow-commissioner, Mr. Maguire, and on my own behalf to bear testimony here to the zealous and careful manner in which Mr. Magrath devoted himself to his public trust and to testify also to the sympathetic and painstaking manner in which he co-operated with his colleagues to deal satisfactorily with all issues which concerned the Commission's welfare. Respectfully submitted,

J. R. COOKE,
Acting Chairman.

History of Illumination

With Special Reference to Spectacular Lighting

By W. D'Arcy Ryan, Director, Illuminating Engineering Laboratory, General Electric Company, Schenectady, N.Y.

(Address to Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Ottawa, Ont., June 25, 1931.)

IT is my privilege to tell you a little about fire, light and illuminating engineering and their relationship to human progress.

Back in the dim and distant past, anyone who had the audacity to investigate or in any way question the laws of nature was severely dealt with. Science, which is based on truth, vision and general enlightenment, is gradually and surely overcoming fear and superstition and the myths of the past have become more or less interesting fairy tales. In many cases, however, they carry a moral of great moment.

It is not difficult for one to discuss in technical terms the science with which he is associated but when his specialized language must be eliminated, in order that he may be readily understood by a non-technical audience, his problem becomes difficult. This suggests the advisability of telling a story about this science rather than attempting even a semi-technical presentation.

We are all more or less familiar with the ancient legend of Prometheus, who stole fire from Heaven and carried it to earth in a hollow reed in order that he might exercise the powers of the gods. For this he was punished by Zeus, who ordered that he be chained to a rock on a mountain side and that each day a vulture should consume his liver which, in some mysterious way grew again each night, thereby furnishing the vulture with a continuous meal ticket. This may bring a shudder in the light of modern thought and advancement and while passing it by, all that we can say is that when and where man first utilized fire and artificial light is not known. He may have retrieved a burning fagot from a tree struck by lightning or material ignited by the heat of flowing lava from a volcano. At some time or other, no doubt, he observed that fire might be kindled by friction when two dry tree limbs were vigorously rubbed together by the action of the wind.

This would naturally suggest to our early ancestors that they could create fire by rubbing two pieces of dry wood together, which would start a small spark and by feeding it with pith, tinder or other inflammable material, a fire of any desired size could be created.

I could take up my entire allotted time in just telling you about the various ingenious methods of creating fire and light throughout the ages. No doubt at an early period it was apparent to man that fire was a protection against ferocious

beasts, and that light and heat offered comfort, convenience and a feeling of security. Just when he began to use cooked meats and other foods in place of eating them raw is also unknown.

At some time the discovery was made that fagots or reeds of the flag order, when saturated with grease or oil, could be used as a torch.

The next step in advance appears to have been the use of hollow stones or shells filled with grease or vegetable oil, into which a wick of pith or other material was inserted. A lighting unit was thereby created which would burn for a considerable length of time. From this period, crude lamps were made of clay, having one, two or more burners. This, in the early history of the human race, was quite as important relatively as our modern electric lights.

The ability to create and use fire and light marks one of the greatest steps in human development and establishes a line of demarcation between man and the lower animals. There is nothing on record to show that any animal in the world's history, except a few trained apes, has ever shown sufficient intelligence to make a fire. Furthermore, many animals will gather around a deserted camp fire and watch it slowly fade, making no effort to add fuel to the dying embers, in order to prolong the comfort they have been enjoying from heat and light. Had animals been endowed with sufficient intelligence and ability to create fire, it is quite possible that our forests would, for the most part, have been destroyed long ago, judging from the great number of destructive conflagrations in the wilds caused by hunters and others who are careless with matches or fail to quench their fires on breaking camp. On the other hand, it is possible that monkeys or other animals would have shown a much higher degree of intelligence and consideration for others than the type of thoughtless human individuals just referred to.

In ancient times and even to-day, in certain parts of the world, man has been and still is more or less of a migratory animal with no fixed abode, moving from point to point during the change of seasons and driving his cattle, sheep and goats to new and warmer feeding grounds. To start a fire by the use of the so-called fire drill or other frictional methods is most difficult under the best of conditions, but during the wet season it becomes a Herculean task. It was, therefore, common for the tribes to carry the fire with them in an earthen pot or container, fuel being replenished in transit. Later, when community life was established, the first fire depots made their appearance; the most famous being the Roman Temple of Vesta, where the Vestal virgins kept fire burning continuously. To this Temple, the people came to obtain fire which they carried in containers to their respective abodes. Contrast this with conditions of to-day when a purchaser of a package of cigarettes or a cigar is usually handed, without charge, sufficient matches to start fifty or more fires under any weather conditions with practically no effort.

For thousands of years, great

attention has been devoted to the creation of lighting units, many of which were used for church ceremonials and festival occasions as well as for utilitarian purposes. They appeared in the following order—fagots and braziers in which oil and fat, soaked wood or rags were burned. Then the wonderful and diversified lamps developed by the Egyptians, Greeks, Romans and oriental nations. After these came the flaming lights of the Middle Ages. In many of the early lamps, olive oil was used as the light giving medium.

I would also like to mention that candles of various kinds made an early appearance and are still in great use to-day. The whale oil lamp, during the latter part of the 19th century, was an important factor in lighting. This was replaced by kerosene lamps and later by gas and electric lights of various types.

In 1933 we are to have another World's Exposition in Chicago, to be known as "A Century of Progress." This will be basicly a science exposition to show the wonderful advancement made possible by various sciences largely developed in the past 100 years. Without the use of fire and light, modern sciences would not be possible, neither would the city of Chicago exist in its present majesty. Consider, for example, the modern skyscraper, steam engine, automobile, steamship, electric generator and the devices for utilizing power and light which have revolutionized our commercial and living conditions. Add to this the great chemical and steel industries, the newspapers and their marvelous printing presses, the telephone, the radio; in fact, almost everything which contributes to our modern civilization depends primarily upon the use of fire and light.

Time will not permit mentioning very many who were responsible for the development of electric lighting during the 19th century, but we may say that Sir Humphrey Davy, in 1802, produced a small electric spark between two pieces of charcoal, using thermocouples to furnish the current. In 1810 he repeated the same experiment with a large battery of two thousand cells and produced a brilliant electric arc.

In 1832 the first patent was taken out on an arc lamp in England by Wright. About this time Pixii made the first tiny machine to produce electricity by having wires travel through a magnetic field. This was followed in 1840 by a platinum wire Incandescent lamp made by William Robert Grove, which he operated from batteries of his own invention.

In 1852 six electric generators of considerable size, for the period, were built in France, not with the idea of furnishing electric light or power, but to produce gas by the electric decomposition of water for use in the oxygen-hyrogen lime light. As this failed to be practical, a man from England by the name of Holmes, who witnessed the demonstration, suggested that they obtain an electric arc lamp and see if it could be operated from one of these generators. A Dobosq lamp was connected to the dynamo and operated satisfactorily. This was followed by intensive efforts in different parts of the world to perfect more efficient and practical dynamos and lamps,

and in 1878 two successful arc lighting systems were completed on this continent—one by Professors Elihu Thomson and Edwin J. Houston, and the other by Mr. Charles F. Brush. About the same time, Thomas A. Edison perfected his high resistance carbonized filament incandescent lamp. Although contemporaneous inventors in this country and abroad were experimenting on this principle, credit was finally given to Mr. Edison as being the first to offer a complete and practical working incandescent lighting system, including a satisfactory incandescent lamp, efficient distribution system with the necessary sockets, switches, fuses and current measuring devices, and also an improved electric generator.

In addition to the development previously mentioned, and disregarding gas and the Joblacoff candles used in France in 1878, we come down from the carbon filament incandescent lamps through the development of the Nernst, tantalum, early tungsten to the modern high efficiency tungsten Mazda lamp of to-day, and in the arc field, from the early types of so-called open arc lamps to long burning enclosed arc lamps, flame lamps and, finally, to the magnetite arcs extensively used for street lighting. We also have the gaseous lamps such as the mercury and Neon of different types which have a wide application.

The vital relation between light and human welfare and the important part it plays in our everyday activities suggested, about 1895, that the study of light and its practical application should be placed on a scientific basis. The response to this demand initiated a distinct branch of science designated as illuminating engineering, and dealing with research, design and application in the use of light. Instruments were designed to measure the intensity, quality and distribution of the light flux and the physical characteristics of the light sources themselves were determined. An intensive study of lighting requirements in stores, mills, factories, streets and elsewhere was extensively carried out by engineers in the field. I was privileged to be identified with this interesting period of development and, when I look back upon the crude light measuring devices in use in those early days and compare them with the modern, highly accurate instruments, I realize that we have indeed made progress. To-day, our illuminating laboratories are organizations of engineers, physicists, psychologists, artists, architects and other technicians, each investigating the relation of illumination to his requirements in order to insure utility, economy, eye comfort, safety and beauty in our lighting systems. Modern lighting designed by capable illuminating engineers anticipates the influence of the light on the delicate mechanism of the eye, on the emotions, on our sense of beauty, with due consideration to such essentials as the proper intensity, quality and distribution of light.

To co-ordinate the activities of independent investigators, the Illuminating Engineering Society, with its 2,500 members, works to improve lighting practice and the dissemination of this information to the public.

Every progressive country has a similar society and the international standards in matters of illumination are reviewed every three years at the International Congress on Illumination. The last meeting of this Congress was held in the United States. The next meeting is called for this year to convene in England and Scotland.

Lighting has so progressed in quality and efficiency until to-day we are actually erecting buildings without windows or skylights. Baseball, football, tennis and other outdoor sports are carried on successfully at night. Ever-increasing levels of illumination are justified by added convenience, speed, safety and, in manufacturing plants, by greatly increased production and reduced spoilage of material in process. The illuminating engineer has had much to do with eyesight preservation and has been instrumental in the preparation of lighting codes for schools, factories, streets and automobile head-lighting. Airplanes are guided at night by light beacons along thousands of miles of airways and land with ease and safety at illuminated airports.

In spite of outstanding lighting developments on every hand, we feel we are only on the threshold of another period of achievement. Already, installations have been made that not only satisfy the most exacting demands for utilitarian and decorative light, but also provide the vital ultra-violet rays to maintain the health of those deprived of adequate sunshine, as well as to stimulate the growth of animal and plant life. To this may be added many applications of ultra-violet and infrared light rays.

Expositions have always been milestones in lighting progress. Many of my listeners will recall the innovations in color, flood and spectacular lighting at the Panama-Pacific International Exposition at San Francisco in 1915, which have since been widely applied. The coming Exposition at Chicago in 1933 will not only recall the advances during the past 100 years, but will also give us many glimpses of new developments and refinements that will be commonplace in a few years.

Electric Water Heating for Domestic Service

By A. S. L. Barnes, General Laboratory Engineer, H.E.P.C. of Ont.

(*Read before Association of Municipal Electrical Utilities at Ottawa, June 25, 1931.*)

REFRIGERATION, vacuum-cleaning, hair-drying, massaging and many other uses to which electricity is applied in modern households are, more or less, luxuries, and, in some cases, are only of direct use to certain individuals of such households, but one of the essential needs of every house, and of each member of it, is hot water, and an ample supply available at all times is a boon to all.

If hot water were needed only during the winter, the obvious way to obtain it would be from the kitchen range or the furnace, but the fact that it is required just as much in the hot weather greatly reduces the utility of this means of supply and makes electricity a more attractive agent because it is available all the year round. Similar reasoning applies also to gas, but this is not so generally available over large areas as electricity and it possesses certain undesirable characteristics from which electricity is free.

Generally speaking, electricity is not economical as a source of heat, as energy in this form can usually be obtained more cheaply from some one or other of the fuels. Considerations of cleanliness, convenience, safety, continuity of supply, etc., frequently outweigh the advantages of cost and of the quicker heating which often characterises fuel-heat and so electricity is preferred—just as many people would rather use oil than coal for heating their houses, even though the cost is higher.

From the point of view of the public, electric water-heating is therefore justified.

From the point of view of the Supply Authority it is justified because the public wants it and it should therefore, if possible, be supplied to meet that want, also it is a means of selling many additional kilowatt-hours which will at least be largely off-peak and *may* be made entirely so.

All electrical engineers who are directly concerned with the supplying of electricity, and I suppose most of you here present are in that category, have an ideal similar to that of the ancient prophets. They looked for, and you—at least in the matter of station loads, if not in that higher sphere which was the chief concern of those men of old—are likewise looking for, the day when "every valley shall be exalted, and every mountain and hill shall be made low".

"Solid" load curves, consisting of stacks of daily load curves cut out on cards, illustrate very vividly the mountainous character of present day electricity loads. They show the high mountain peaks towering far beyond the snow line, where all is

cold and bleak (unremunerative), and the dark, damp valleys where no sunlight penetrates and crops (financial returns) are small indeed.

What we need is terrain free of those awesome precipices, frowning crags and yawning chasms of the solid load curves—a region of gently rolling land and fertile plains whence returns on invested capital will be as great as it is possible to make them—this is the ideal towards which we strive.

I am well aware that this picture is not a perfect one, but it will serve, within the limits to which it is here confined, as a general illustration of present-day load conditions.

Great and numerous have been the efforts and discussions made and held in recent years which have this desideratum as their ultimate goal, but we are still a long way off.

Domestic uses of electricity have grown apace within the last few years and in Ontario the average monthly kilowatt-hour demand per consumer has increased from about 80 in 1924 to well over 100 to-day, this is all to the good but much of it is relatively short-hour use and by no means entirely off-peak; these are conditions to which electric water-heating is not necessarily subject.

Kw-hr. Demand of Electric Water-Heaters Greater Than That of Other Appliances.

The following Detroit Edison figures were published in the *Electrical World*, of January 11th, 1930.

Annual Energy Consumption and Load Factors of Domestic Appliances

Appliance	Kw-hr.	Load-factor Per cent.
Lighting	540	38
Oil-burner	258	65
Refrigerator	542	87
Range	1480	28
Water-heater	2825	56

The foregoing Table tells a story which amply justifies a Paper on the subject of electric water-heaters. It is true that refrigerators and oil-burners both, in this Table, show higher annual load-factors but there is a very striking difference in the number of kilowatt-hours required; moreover the capacities of the heaters reported on ranged from one to six kilowatts, the average being 3.6 kilowatts. Water-storage capacities ranged from 8.3 to 50 (imp.) gall., the average being 20 gallons. These facts indicate that most of the heater capacity was operated intermittently, so the load-factor would naturally be fairly low. Due, probably, to the relatively high cost of current in Detroit, all the kilowatt-hour consumptions in the Table, and particularly those of the water-heater, appear to be low compared with Ontario standards.

Present "Hydro" Domestic Kw-hr. Demand per Consumer per Month

From figures in Table D of the 1929 Annual Report of the Hydro-Electric Power Commission of Ontario the following facts, relating to a total of 255 cities, towns, small towns, villages and suburban areas, have been deduced:—

DISTRIBUTION OF DOMESTIC KILOWATT-HOUR DEMAND PER CONSUMER PER MONTH

Kw-hr.	11–40	41–100	101–150	151–200	201–300	Over 300
Actual number of Instances......	95	120	28	9	2	1
Per Cent. of Total..	37.3	47.0	11.0	3.53	0.78	0.39

The foregoing figures show that the average monthly kw-hr. demand per consumer is less than 40 in nearly 40 per cent. of the cases considered and less than 100 in 84 per cent. of the cases.

Cities having populations of 10,000 or over give a better showing but are still far from the ideal. The city figures are—Less than 100 kw-hr. per month, 71 per cent.; less than 200 kw-hr. per month, 87 per cent.

As the average demand of domestic electric water-heating requirements is about 400 kw-hr. per month, the advantage of installing electric water-heaters is obvious.

ACTUAL AND THEORETICALLY-POSSIBLE WATER-HEATING DEMANDS ON H.E.P.C. SYSTEMS:

According to figures given in the *Hydro Bulletin* for October, 1930, the estimated number of electric water-heaters in use in Ontario at the end of 1929 was slightly over 38,000 The estimated installed capacity was 57,204 kw.,—this equals about 1,500 watts per heater, indicating that a large proportion of these heaters is operated intermittently, many of them being, probably, of 3,000 watts capacity.

The number of domestic consumers connected to the "Hydro" systems at the end of 1929 was more than 415,000 of which about 40,000, or, say, 10 per cent. had electric water-heaters.

Assuming 600-watt heaters, operated continuously, to be capable of supplying the hot-water demand of all the domestic consumers, the total kw. demand, if all such consumers had electric water-heaters, would be 225,000 kw. and the annual kw-hr. demand would be almost 2,000,000,000.

The saturation point for electric water-heaters is a long way off yet; only 10 per cent. of the market has been reached and the rate of reaching it is less than 2 per cent. (of the present number of consumers) per annum, thus it will take 50 years or more to reach saturation, and it will indeed be surprising if the number of domestic consumers does not grow very considerably greater in that length of time.

It is evident from the foregoing that in domestic electric water-heating lies a huge potential market for electrical energy and that there is no fear of reaching saturation point in a short time.

It should be pointed out here that the kilowatt-hour demand of a family for electric water-heating purposes will, with relatively little variation, be the same whether a small-capacity heater operated during many hours of the year, or a large-capacity one

operated intermittently for a much shorter total period, be used.

WHAT A KILOWATT-HOUR WILL DO IN WATER-HEATING:

One kilowatt-hour, with a well-lagged water-heater system, will supply about 2.6 imp. gallons of water at 160 deg. F., if the initial temperature is 50 deg. F. A family of 3 or 4 persons can obtain all the hot water it reasonably requires from a 600 watt heater used continuously—this indicates an average daily demand of approximately 36 imp. gallons of water and, roughly, in average figures per person per day, 10 imp. gallons, 175 watts and 4.0 kw-hr.

TYPES OF ELECTRIC WATER-HEATERS:

Three types of domestic electric water-heaters are in common use to-day—immersion, circulating, and clamp-on. The last-named has three advantages, worthy of special mention, which are not possessed in the same degree by the others:—

(a) It can be very readily installed and removed.

(b) It can be placed at any level on the hot-water tank.

(c) One heater can readily be placed fairly high up the tank for quickly heating a small supply of water, while another can be placed lower down to furnish a larger supply.

It is claimed in some quarters that the clamp-on type of heater is as efficient as the other types but for identical conditions of temperature and amount of heat-insulation used this does not appear to be possible.

HEATER CAPACITIES

As the average small home can be supplied with plenty of hot water by a 600-watt heater operated continuously and provided with hot-water storage* it is evident that any heater of appreciably larger capacity will have to be operated intermittently.

A relatively very high-capacity heater can be used with practically no storage but it then comes into the "geyser" class which is expensive to install and to use and is of very little benefit to the central station; this type is not considered here.

Depending on conditions and individual preferences, water-heaters in use to-day in the average home vary from about 600 watts to 5,000 or more, the former having hot-water storage of about 30 gallons and the latter as little as 10 or 12.

The character of intermittent operation can be varied within wide limits by varying the amount of storage provided and it is this flexibility that helps to make domestic electric water-heating so attractive to a Supply Authority because it makes possible the use of off-peak electrical energy. No other domestic appliance is invested with such flexibility.

METHODS OF SUPPLY OF ELECTRICITY FOR WATER-HEATING

There are three principal methods of supply of electricity to consider in connection with the domestic water-heating problem.—

(a) Continuous heating.

(b) Intermittent heating, unrestricted use.

(c) Intermittent heating, restricted use.

Continuous heating involves the

*If the electricity supply be continuous and the hot water demand, as it always is, be intermittent, it follows that there must be some storage of hot water.

use of a low-capacity heater with fairly ample storage; in Ontario, current may be obtained on a flat rate, and the capacity of the heater is checked from time to time to make sure that it has not altered or that a larger heater has not been installed.

Intermittent heating with unrestricted use of current involves the use of a higher-capacity heater than that required for continuous heating; less hot-water storage capacity, depending on the heater capacity, will serve and thermostatic control is essential if economical operation is to be attained. The current is metered and the rate should be high enough to take care of the fact that the demand will frequently be on the peak. In a discussion on electric water-heating in England last year one engineer stated that with thermostatic control, there were only 20 days out of 182 days when his heater missed coming on the peak.

Intermittent heating with restricted use of current gives an off-peak load and the heater capacity and amount of hot-water storage needed depend largely on the degree of restriction which the load-factor of the supply system makes it necessary to impose. A fairly low meter-rate is applicable and thermostatic control should be provided.

Methods of Control of Current for Restricted Use

A very great deal of thought has been given, especially in Europe, to the matter of keeping electric water-heaters off the peak.

Some devices, such as change-over switches and current-limiters, merely keep a heater off the consumer's own peak and although they are used to some extent they are not greatly in favour.

For keeping off the system peak time-switches are in extensive use in England and European countries generally, and in the latter many thousands of so-called synchronous-motor switches, which evidently operate on the telechron clock principle, are said to be employed.

Control by such devices is not ideal because, in setting them, allowance has to be made for the fact that peaks do not always occur exactly at the same time, thus only a coarse adjustment is possible.

Control direct from a station or sub-station is the best, as the operator can switch the devices on and off so as to avoid the peak no matter when it may occur.

This may be accomplished by means of a pilot-wire run to each consumer's premises—it is satisfactory but rather expensive and adds to the amount of wiring over or under the streets. Carrier-current control is being experimented with and should prove satisfactory if the price of the necessary equipment can be made reasonably low. Control by radio is a possibility of course but so far as is known not much work has been done on this yet.

Regarding carrier-current control, information was received a few days ago to the effect that while, in England, this method is hardly used, if at all, it has been in actual operation to a considerable extent in the Isle of Man for several years—efforts are being made to obtain details of the system said to be in use there.

Heat-Insulation

One of the principal factors in a

successful domestic electric water-heating installation is efficient heat insulation of the tank and the hot-water pipes leading therefrom. Heat losses may be divided into three sections—radiation from the tank, radiation from the hot-water pipes and conduction along all the pipes leading to and from the tank and along the water in such pipes.

There is no convenient means of preventing or even reducing the conduction, but both of the other sources of loss may be reduced greatly by adequate heat-insulation. Radiation loss from the tank is the greater item but that from the hot-water pipes should not be ignored.

Since radiation losses are dependent upon the difference of temperature between the radiating surface and the surrounding air and increase very rapidly with increase of this difference (unless the difference is very small) it is desirable both to have thermostatic control to prevent the water from reaching a higher temperature than is necessary and also to set such control to operate at the lowest temperature which will satisfy the consumer's requirements; this seems to be from 140 to 180 deg. F.

Another cogent reason for keeping down the temperature is the need, in certain districts, for minimizing scale formation due to hard water; 160 deg. F. seems to be suitable in many cases and this, fortunately, is a satisfactory temperature for ordinary household needs. If 180 degrees F. is exceeded scale formation becomes a serious matter and of course it causes great reduction in the efficiency of a water-heating system.

To return to the heat-insulation problem, from which the foregoing paragraph is a digression—an unfortunate feature about such insulation is that, beyond a certain point, the addition of extra thickness of insulation accomplishes so little that it does not pay to install it.

For example, tests carried out some years ago at the laboratories of the Hydro-Electric Power Commission gave the following results*:—

Thickness of Insulation (Inches)	Radiation Loss (Watts)	Difference (Watts)
½	525	—
1	375	150
2	300	75
3	275	25

The addition of still another inch of insulation would make hardly any appreciable reduction in the loss below that shown for 3 inches. There is so little difference between even 3 inches and 2 inches that this extra inch is hardly justified.

These tests were made with hair-felt and, for that material, about two inches thickness is all that is really needed. Other materials, depending on their heat-insulating properties and their cost installed, would warrant greater or less thickness accordingly. Where rates for electricity are high it will pay to provide more heat-insulation than where they are low.

WATER-HEATING AS A SUMMER LOAD

Wherever there is a domestic heating-furnace equipped with a coil for furnishing a supply of hot water in the winter months, it is possible to

*See Hydro Bulletin. Jan. and March-April, 1922.

arrange an electric water-heating system to be operated when the furnace is not in use. This combination method of heating is already in use to a limited extent. For such service, no off-peak control ought to be necessary as the entire use of the electric heater would be off the winter peak—the one that really matters.

The difficulty that arises in such a case is that the hot-water tank would of necessity be covered with heat-insulating material to make the electrical heating system effective and since the furnace coil, as usually installed, takes care of the household requirements with the tank unlagged, there would be a very large surplus of hot water after the tank was lagged. There are three possible remedies for this—to take the lagging off the tank during the winter months, to draw off the excess hot water—both of these are wasteful and should not be tolerated, though an unlagged tank is usual at present where the furnace is used for water-heating; the third remedy is the obvious one of reducing the quantity of heat taken from the furnace by water-heating, which may be done either by using a smaller coil in the furnace or by placing it in a location where it will not absorb so much heat. Summer use only of electricity for water-heating results in the sale of fewer kilowatt-hours than all-the-year-round use but it could be compensated for to some extent by charging a specially low rate, thus inducing people to furnish themselves with a more ample supply of hot water than they might otherwise be inclined to do.

European Experiences

Reference to electric water-heating in European countries has already been made but some of the results obtained in improving load-factors are worthy of special mention.

Switzerland seems to have done more than any other country—In Basle, electric water-heaters, controlled by time-switches which are hired out to the consumers, operate from 10 p.m. to 6 a.m. In 1915 the load-factor was 56 per cent.; by 1924 it had risen to 74 per cent and is, doubtless, higher now. One effect of the water-heating load in this city has been to change the time of minimum load from the early morning hours to a short period at mid-day—this of course has been done by filling up the early morning valley—not by deepening the noon-day one. It is reported that, in Zurich, out of a total connected load of 220,000 kw., 120,000 kw. (55 per cent.) is heating equipment operating during off-peak hours. In Berne the load factor in 1930 was 90 per cent., due mainly to the use of electric water-heaters.

The *Electrical Times* of July 31st, 1930, showed a 24-hour load curve for a Norwegian supply system in which, at 4 p.m., the load was at its maximum, and the lowest load for the day, 87 per cent. of the maximum, occurred at 3.30 a.m.; the average for the whole day was about 92 pe cent. of the maximum. It was stated that the curve was for a domestic load only, there being no industrial load at all. This result is due to the fact that domestic electric supply is charged at so much per kilowatt per year and that efficient, low-wattage electric cooking and water-heating devices are used extensively.

SUMMARY AND CONCLUSIONS

From the above discussion of the subject it is evident that in electric water-heating lies the best means at present available of increasing the kilowatt-hour demand of domestic consumers, and that it is possible to do this without adding to station peaks—very substantial increases in load-factors have been obtained in Europe by this means.

If all-the-year-round operation is employed, it is necessary, in order to keep off the station peaks, to employ time-switches or other controlling devices; there are opportunities, however, of creating a purely summer load where furnaces can be used for water-heating during the cold weather, and in such case no control is needed as the load would be off the winter peak. It would, of course, be necessary to cut off the supply of electricity from such "seasonal" heaters during the winter months.

As the cost of electric heat is usually higher than that of fuel heat, it is essential in the case of the former to provide adequate heat-insulation on the tank and on the hot-water pipes leading therefrom; with the temperatures ordinarily employed, it is not necessary to have more than about 2 inches thickness of hair-felt insulation, or its equivalent in other material.

The maximum hot-water temperature should be kept as low as is practicable, consistent with meeting consumers' needs, because in this way radiation losses are reduced and in many districts where hard water must be used the formation of scale is minimized.

APPENDIX

The *Electrical World*.
Feb. 22nd, 1930.

Analysis of a two and one-half month field test of a 20 gallon automatic electric hot-water tank insulated with mineral wool and using a 3 kw. triple-heat (185, 155 and 135 deg. Fahr.) immersion heater shows that—

(1) The 3 kw. heater can be added to an electric range installation without increasing the fixed charges of the central station.

(2) Frequent operation of the heater gives greater diversity.

(3) The average kilowatt-hours for electric water-heaters need be no greater than 300 per month for the average family.

(4) Most families can get sufficient hot water on low heat.

(5) Operating radiation losses on low heat are as low as 45 kw-hr. per month, proving that automatic operation is more economical than manual.

A range installation is made on the basis of 8 kw. connected load, 5 kw. average maximum demand and 3½ kw. average demand.

Test results show that the range and water-heater overlap about 50 times per year maximum and that the average duration of overlapping is 10 minutes. The average maximum demand of the electric range and water-heater exceeded the 5 kw. average maximum demand of the range.

May 3rd, 1930.

The following water-heater data are given.—

RESULTS FOR 10 FAMILIES—OHIO EDISON CO.

ITEM	AVERAGE	MAX.	MIN.
Tank Capacity, Gallons (U.S.)	76	120	40
Average Monthly Kw-hr.	265	438	114
Average Monthly Gallons (U.S.)	928	1530	400
Average Monthly Bill	$5.18	$4.40	$1.66
Persons in Family	5.7	5	2
Averages per person :			
Monthly Kw-hr.	72	101	35
Monthly cost	$0.88	$1.22	$0.46
Daily Gallons (U.S.)	8.5	11.8	4.1

The rate for energy is 1½ cents for the first 100 kw-hr. and 1 cent for all additional.

August 23rd, 1930.

According to an article in this issue no less than 80 electric utilities in the United States were considering establishing a rate of one cent or less per kilowatt-hour for off-peak electric energy for domestic heating and water heating.

January 10th, 1931.

An article dealing, among other things, with domestic electric water-heaters gives curves showing gains in load-factors of from 8 to 16 per cent. as having been obtained from ranges and water-heaters in the United States.

May 16th, 1931.

There is an excellent article in this issue on "Water-heating as an Element of Residential Load". It is based on "a long series of laboratory tests".

Some of conclusions are quoted below—they corroborate many of the statements already made in the main body of this Paper.

With modern, well-insulated tanks, hot water may be delivered at tank outlet at a monthly efficiency as high as 93 per cent. Hence, no important reduction in energy consumption can be hoped for by increasing tank insulation.

Full automatic hot-water service, under northern conditions in the average home, can be delivered for 335 to 415 kw-hr. per month. The higher energy per month, by reason of securing desirable load-curve characteristics, may very well result in lower utility costs to serve per month. Therefore, the choice of system should not be based on kilowatt-hours per month only.

The energy consumption per month, if the hot-water consumption is of the order of 10 gallons per person per day, may be as low for full automatic hot-water service as for manual service, which latter requires that the housewife turn on the switch well in advance of the time she wants hot water.

The monthly losses from the tank, as actually measured under operating conditions, are substantially lower than calculated from idle losses times hours of use, because under operating conditions the lower part of the tank is usually at fairly low temperatures.

Pipe heat-losses in the home are considerably higher than tank losses.

It is practicable to deliver high-grade hot-water service from a carefully designed heater with a temperature variation at the tank outlet not exceeding plus or minus 10 degrees Fahr. during the entire day. This is higher quality service than exists in nearly all homes to-day.

The "flexibility" of electric water-heating systems, to meet unusual or emergency hot-water withdrawals, varies enormously. If a tank should be completely emptied, 130 degrees Fahr. water will be available in one-half hour with the most flexible type to 9¾ hours with the least flexible.

It is practicable to deliver full automatic hot-water service to the average customer, under northern conditions, with a tank of 30 gallons capacity in combination with a time-switch and with little or no addition to the diversified demand imposed on the station by the domestic customer using an electric range.

It is possible, with a properly designed water-heating system, and using a relatively small tank, and without the use of time-switch or other auxiliary control device, to obtain 25 per cent. of the energy consumption in the night hours.

A two-unit system will impose a smaller addition to the diversified demand of a household already using lights, appliances and range than will a water-heater of high or intermediate wattage. This follows from the fact that some hot-water withdrawals occur during the cooking hours and the higher the wattage the more the water-heater load tends to concentrate into this cooking demand period. On the other hand, the low-wattage, base-load unit, since it cannot quickly recharge the tank after ordinary water withdrawals, must consume fewer kilowatt-hours during this peak cooking period.

The connected load of a properly proportioned two-unit system is not an indication of its diversified demand. The booster unit is in operation so few hours per month during the 4 p.m. to 8 p.m. period that its effect on diversified demand can be nearly neglected.

Electrical Review (England). September 13th, 1929.

An article on Thermal Storage Water-heaters gives some data from Germany; the following items are taken from this source:—

Persons per Family	No. of Families	Kw-hr. per Family per month	Average kw-hr. per person per day
2	27	126	2.07
3	21	145	1.59
4	19	149	1.22
5	9	179	1.18
6	6	183	1.02
7–9	3	203	0.87

The tanks were of 22 gallons capacity. The heaters were controlled by a time-switch on 8-hour loading. It is interesting to note that one time-switch controlled all the heaters in one set of flats. This clearly indicates a means of making off-peak electric water-heating more attractive to dwellers in apartment houses than if time-switches had to be installed for each consumer. The flats were of from 3 to 5 rooms occupied by people of middle class. The heater capacities are not stated.

Electrical Industries (England)
June 4th, 1930.

It is stated that in Amsterdam and the Hague, up to April 1930, no fewer than 8,825 night-tariff water-heaters had been installed, increasing the night load by 8,000 kw. They are connecting additional water-heaters at the rate of 200 per week, every one controlled by a synchronous-motor switch; maintenance costs on these switches are said to be much less than on the best time-switches.

In discussion on electric water-heating, one speaker stated that where water-heaters with sufficiently low-loading and thermostatic control were installed the load-factor was extremely good and in the case of his own house was over 80 per cent.

The *Bulletin* (H.E.P.C.)

The following data are taken from the *Hydro Bulletins* of the dates given:—

ELECTRIC WATER HEATERS

Date of Bulletin	Estimated number in use at end of previous calendar year	Saturation (Per cent.) of number of Consumers Using Appliances	Estimated Total Installed Capacity (kw.)	Average Capacity per Heater Watts
August, 1925....	16,665	4.8	33,330	2,000
September, 1926....	24,726	7.0	49,452	1,900
September, 1927....	26,069	6.9	39,100	1,500
August, 1928....	32,211	8.2	48,316	1,500
September, 1929....	37,028	9.0	55,542	1,500
September, 1930....	38,136	8.8	57,204	1,500

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February 22nd, 1930.
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June 4th, 1930.
"Domestic Water-heating." General discussion by various speakers.

Merchandising by Public Utilities

By H. E. Speare, Executive Manager, Central Station Retail Shop, New York, N.Y.

(Read before Association of Municipal Electrical Utilities at Ottawa, June 26, 1931.)

MAY I thank your committee and you for your confidence in our magazine, shown by your invitation to me to speak at this very interesting convention.

I have been asked to talk about, first, the justification of utility merchandising; second, give you some data on this disturbing subject of prohibiting utilities retailing appliances; and, third, refer to a policy for power company retailing that would be successful and profitable.

Justifying utilities merchandising brings before us one of the greatest educational, promotional and selling jobs in the history of this continent. Listening to some of our oldest merchandise managers recount the obstacles that they had to overcome years ago, and to realize that to-day they are responsible for a $600,000,000 retail business, you ask yourself who can be so shortsighted as to suggest and foster legislation against their continuance? Who with any foresight would exchange the experience, vision, proven merchandising ability, technical electrical knowledge, which thousands of our merchandise managers have, for a set of mixed dealers outlets?

Everything that has been difficult and expensive to do in promotional work has been left to the utilities from the very beginning up to their creditable assistance in helping refrigeration reach its present figures.

1. PUBLIC UTILITY MERCHANDISING IS CONSONANT WITH PUBLIC INTERESTS. IF CONDUCTED ON SOUND MERCHANDISING POLICIES IT WILL ALSO BE CONSONANT WITH ALL OTHER ELECTRIC APPLIANCE RETAIL OUTLETS.

2. THE LARGE VOLUME OF APPLIANCES ENABLES UTILITIES TO INCREASE "SEND-OUT," THEREBY AIDING IN A REDUCTION OF RATES.

Every utility is striving to give its customers the lowest possible rate. A number of companies have reduced their rates in the States in the past two months, and in checking this we find that their appliance business is good and this is one of the principal reasons why they could do it. The public wants lower rates occasionally and in order to do this the utility must sell more electricity, meaning more appliances must be put on their lines. Hence their willingness to spend large sums in promotional and sales work. Utilities must increase their appliance volume or rates will either stand still or go higher. The public, I believe, realizes this and their large purchases from utilities really constitute a vote in the utilities favor.

One merchandising feature that is not clearly understood by those outside of the industry is that utilities try to sell load builders which even out the valleys. When accomplished, this effects economies that are of real value to the utility. Department stores, dealers, etc., don't give this feature a thought and we know that it is of extreme importance as one of the reasons why rates can be reduced.

3. TO STUDY, INTRODUCE AND PROMOTE NEW GOOD QUALITY APPLIANCES:

It is doubtful if the public or dealers realize the expense power companies go to in maintaining laboratories for the testing and approving of appliances. These laboratories have the finest guages and testing instruments, and men in charge who are engineers. Only quality appliances get by because they are put to rigid tests and must be well designed, modern, stand abuse, and have sales possibilities. Dealers are safe in following the utilities' judgment in the choice of appliances, and this knowledge and assurance have not cost them a cent nor any sad experiences.

Utilities, in selecting appliances, also keep in mind the efficient and economical features of a unit when testing it. If two appliances are equal but one is a little wasteful of electricity most laboratory chiefs will turn it down in favor of the economical appliance. The utility does not want a customer's bill to suddenly jump out of proportion, and thereby safeguards this possibility by accurately testing every appliance before offering it for sale.

4. TO KEEP THE PUBLIC INTERESTED IN APPLIANCES, SO THAT THEY WILL USE THEM, RECOMMEND THEM TO FRIENDS, THEREBY CREATING A GREATER DEMAND:

Almost every utility has at least one fine building, usually headquarters, which is pointed out as one of the city's impressive buildings. Their branch stores are clean, neat, well arranged and manned by a good class of sales-person. This lends dignity to the appliance industry and with their attractive window displays the passer-by is impressed and stops and looks at the newest appliances in the windows. The high class manner in which central station shops sell their merchandise and the prompt way in which they take care of all complaints all tend to keep up the customer's interest in her appliances, and her enthusiasm to her friends actually creates more sales, all other appliance outlets thereby gaining.

5. TO DEVELOP SUBURBAN AND RURAL SECTIONS:

Our suburban and rural sections are a great deal to the utilities' promotional work—work which no manufacturer nor dealer could attempt. Yet utilities have been promoting it for years, and now they are deriving the benefit of their work, and the farmer is paying a lower rate, and the farmer's wife receives the benefits of labor-saving devices, and in the barn we find every possible aid to sanitation, to less waste and more general efficiency. One of our largest mail order companies is quoted as stating that it had sold hundreds of thousands of appliances to rural families, and that it could not have done so if the lighting companies had not first introduced appliances, and

continued their interest in them. Keep in mind, that if the farmer and suburbanite no longer get power company co-operation, and are wholly dependent on the dealers, that they are open to the dangers of distress merchandise, rebuilt machines, discontinued models and whatnot. Utilities do not operate this way. Our rural sections are entitled to know everything about new appliances, and as there are not many stores for them to trade with, the utility is their only safe source of information. The sale of extra appliances to the farm gives the power company additional money, and encouragement to increase its lines, to go deeper into rural sections, and, most important of all, helps pull the rate down.

If utilities stop retailing, who will carry on the work? We can't ask the utility to give up urban territory and keep suburban and rural sections, nor can we expect the dealer, on his own smaller discount, to carry on promotional work. Last year, the utilities sold about 50 per cent. of all the appliances sold in rural sections—in the big cities about 15 per cent. That gives us a good idea of the value of the utility in suburban sections.

6. Appliance Service and Its General Helpfulness to Industry:

I doubt if there is a central station in the country that would not gladly give free service to a customer who told it that the company from whom she bought her electric appliance could not make it run properly. One of the most helpful aids that has been given to the industry is the liberal attitude of the utilities regarding service. This policy makes the customer feel safer when buying. We have all heard salesmen for dealers say that many sales have been closed when the customer was skeptical and the salesman said, "the utility also sells this same machine and if we go out of business, it will always be here and take care of you." The very presence of the utility gives a purchaser a feeling of security.

7. Helping To Maintain Electric Leagues and the Value of Domestic Departments:

In many cities there is an electrical league backed financially to a certain extent by the utility. These leagues give free of charge every possible help to the housewife. She can attend cooking classes, take ironing machine lessons, learn how to get more out of her appliances and how to be more economical in the use of electricity, and receive instructions on kitchen and dining room arrangement and decoration, see demonstrations on treating grease spots on clothes and other pieces of material, whether or not she has a washer.

The utilities perform a wonderful service to the customers on their lines by the continuance of these leagues.

8. Co-operating With The Contractor-Dealer on Wiring:

Many a contractor-dealer owes his prosperity to his utility. Many merchandise managers learned that the contractors were cutting prices among themselves to get jobs and have shown them how wrong they were to follow such a policy. Many utilities turn over sales to them on heating units, range installations and similar jobs on major appliances. Some utilities will finance dealers when they have a high priced job on an oil-burner or other costly installation.

In some cities, the contractor-dealer gets more than half of his business from his lighting company.

9. EMPLOYMENT TO LARGE SALES AND PROMOTIONAL DEPARTMENTS:

One feature of utility merchandising that we all have given too little thought to is employment. Some of our largest companies have 300 or more people on their payrolls in this department. Salesmen, whether or not they are on commission, are supporting their families and a goodly percentage stick for years. To dissolve these many organizations would be a calamity and would slow up the electric business noticeably.

10. AID GIVEN DEALERS IN LARGE CITIES BY CAMPAIGNS WHICH STIMULATE DEMAND AND BREAK DOWN RESISTANCE:

The value of campaigns is not to be questioned. The utility and manufacturers spend a great deal of money on advertising and other forms of promotional work. No utility can sell everybody. If the utility does not include dealers, the latter benefit, nevertheless. Neighborhood stores get the patronage of many husbands and wives after dinner because one of them has read the ad. and is interested but can't go to the city. Most utility stores close at 5 p.m. and dealers have the evening hours to themselves. In big cities, with their large transient trade, dealers pick up many sales which originated from the utilities newspaper ads. In territories where they co-operate with the dealer, figures show that the dealers' figures increase very satisfactorily. However, you must have the utility to put a campaign over.

This year, in February, theKansas City Gas & Electric Co. tried out the dealers to see what they could do alone. They put on a waffle iron campaign, but stayed out themselves. Just the dealers did the selling. The utility spent exactly the same amount of money it spent last year, had the same demonstrators, same premiums, same working elements as in 1930. In that campaign, through its own efforts, it sold well over 1,000 waffle irons. This year all of the dealers combined sold less than 100. This is one more justification for the need of the utility.

11. FEELING OF SECURITY BY CUSTOMER KNOWING UTILITY IS BACK OF ELECTRIC APPLIANCES:

Every purchaser of anything mechanical likes to feel that there is some company of responsibility in the neighborhood who will back up the appliance in case of trouble. Unquestionably, the utilities have earned this distinction. During years of bringing themselves to the customers' attention, monthly through their bills, they have built up in the public's mind "electricity — appliances."

The power company is just as staple and firmly intrenched as the telephone, electric street cars or trains in the thoughts of the public, and this feeling of security is not only helpful to the industry but is of definite value to a community because, after all, it is a fact.

A few years ago the big Brooklyn Edison Co., discontinued all outside selling—only the girls on the floor remained. After a year the appliance volume slipped and the large electric shops and department stores asked the company to come back on its old

basis. They missed the vigorous promotional work of their "big brother," so they said. And they did.

12. UTILITY VOLUME HELPS MANUFACTURERS PRODUCE ON A LARGE SCALE, THEREBY REDUCING RETAIL PRICES:

The utilities' volume does help our manufacturers in a big way. The additional number of units sold by the utilities has an important place in a factory's output. On October 9th, the New York Edison put on an employees' campaign which lasted until December 31st. In 68 days they sold 6,298 refrigerators. It is true the utility gave its employees a discount, but what dealer wouldn't give his own employees a complimentary saving? The employees, through their enthusiasm, sold 732 outside and turned in 8,000 prospects. Think what this means to the industry and the manufacturers, and also realize the number of people who will enjoy the advantages of an electric refrigerator. It's educational.

13. WITHDRAWAL BY THE UTILITIES WOULD NOT MEAN GREATLY INCREASED SALES BY DEALERS AS HUNDREDS OF MANUFACTURERS WOULD OPEN THEIR OWN BRANCHES IN KEY CITIES AND DO THEIR JOB DIRECT:

Many dealers, department, furniture and hardware store executives do not realize that should utilities discontinue their retail activities and thereby stop their newspaper advertising, stop sending mailing pieces out with their bills, take their men off the streets, do away with their canvassing that they would receive the shock of their lives at the startling dropping off of the interest in appliances. I don't mean that all our factories would have to close, but it would put a big dent in this year's volume.

Who would take the place of the utility and feature and push sales on all these appliances? The utility helps hundreds of manufacturers and no department store, nor any other kind of a store can do this tremendous job efficiently.

It would mean that the factories would be forced to set up their own wholesale and retail headquarters in key cities and do a big part of their job direct. A large number of reputable manufacturers who don't do much with utilities are selling just this way to-day and it should be a warning signal to all retail outlets that if the appliance business throughout this continent is conducted on straight, profitable, and co-operative plans that it can be made consonant with retail outlets and the public.

* * * *

A word about the agitation in the States concerning utilities being asked to cease wholesaling and retailing appliances.

In Missouri, the law was defeated and the two principal points brought out were: first, that utility merchandising helps all dealers in appliances, and, second, how the sales of appliances have made it possible for utilities to lower the rates by increasing the load. This point shows how utilities render a definite service to the public by promoting appliances, thereby lowering the rates.

Back in 1928, Pennsylvania defeated the passage of a similar bill. A pertinent paragraph from the decision reads: "The public has not been educated with regard to the

multitude of conveniences which electric current will supply. To furnish the housekeeper with current alone would have resulted in neither profit to the company nor convenience to the customer. What the latter wanted, and what the Legislature intends to grant when it authorized the respondent to furnish light, heat and power by electricity, was something more than furnishing the customer with the end of an insulated copper wire that he did not know how to use, or had not the appliance to use. It was intended that he should have and the company should furnish the conveniences that could be obtained by the use of the electric current.

We have some cities where the power companies do not merchandise, Cleveland, Ohio, for instance, with 65,000 meters. A number of manufacturers tell us that their shipments into Cleveland are away below those into cities of the same size or same number of meters. The Ohio Public Service Co., C. L. Dunn, merchandise manager, serves the small towns surrounding Cleveland, Alliance, Elyria, Lorain, Mansfield and others with a total of 80,980 meters and does an exceptionally fine job, its figures for 1930 being $1,363,000 for appliances and an additional $977,000 in securities—a total of $2,340,000 to its 80,000 customers. The city of Sandusky leads in dollars per customer with $21.84, the company's average being $16.83.

There is an electrical league in Cleveland which, we are told, is supported by the utility and league members—the utility contributing almost up to 75 per cent. of the expense to maintain it. This league does a fine job, holds cooking classes, teaches women at no cost how to use an ironer, how to get the best out of their washer, cleaner, grill and other valuable helpful household information. It also operates whole heartedly with dealers. If it weren't for the good promotional work done by the league, the appliance volume in Cleveland would be almost nil. Dealers alone just cannot do the volume that is obtainable and possible.

Department stores claim they are not causing any of the agitation—perhaps not, but they are keenly interested in the immediate future, and only recently there was an article in *The Chicago Herald & Examiner* quoting D. F. Kelly, president of the Fair Store and also president of the Retail Dry Goods Association, in which he said: "As soon as it can be shown that merchants are capable, and I believe that will be soon, we shall expect the utilities either to so arrange their distribution that the dealers shall have an entirely unhampered opportunity to build up a large and growing business at a proper profit, or else we shall expect the utilities to fade out of the merchandising picture."

There is a trade paper called *Home Ware*, published for the department stores. On the front cover of the February, 1931, issue are 17 electros of appliances and a block of big type asking "Who Will Claim These Profits." The text paints a glowing future for the department store which retails appliances and appeals to those who do not to get busy. On page 17 there is an article by the

editorial director in which he says, quoting a Mr. Guernesey, "After every depression, there emerges some new industry which we can point to in later years as the thing that pulled us out of the hole. Railroad building and the electric power industry pulled us out of two. Automobiles came to our rescue in 1921, radio was of assistance in 1927, and now, perhaps, the electrical appliance business will be a means of improving business materially in its climb up the present hill. Certainly this industry is only in its infancy. There is little co-ordination of its several parts and its sales promotion is spasmodic and amateurish. I could ask no better life than to get into that industry at its present stage." So, Gentlemen, you can see what this trade paper man thinks of our $600,000,000 business.

Utilities want the department stores to sell appliances, but they won't let them dominate the industry. Our magazine has taken its stand and has published it. In our April issue, we commented on the committee of 6 utility men and 6 department store men who are to get the industry on its feet. We can't see any real value in this committee because we know department stores policies and said so. We received some criticisms of our statements. One week later, Wanamaker's put on a big sale of a well-known electric refrigerator and materially cut in price. A day or so later, Gimbel Bros., did the same with a well advertised electric clock.

There are many fine reputable department stores, but we must treat them as a whole. Their job is to sell and make money, and if it is necessary to trim the price a little, it is just too bad. In the case of Wanamaker's, they were notified in the Fall that the model referred to would be discontinued on January 1st. A big utility not far from New York also sells the same refrigerator and got the same notice. On January 1st, the utility's inventory was clean, and if reports are true, the department store still had 30. Hence the sale.

* * * *

An ideal plan of appliance merchandising for which all power companies are seeking is one which will satisfactorily increase the domestic load at a reasonable cost and at the same time will maintain the utility in friendly relationship with all other branches of the electrical industry.

The plan presented has been employed by the San Joaquin Light and Power Corp., of Fresno, Calif., for nearly five years. Their domestic loadcurve is going up, not by jumps but steadily and the rate of their increase is well above the national average. Also, they have kept the friendship of the electrical industry —in itself no mean performance.

All merchandising for the San Joaquin Light and Power Corp. is done through the medium of a subsidiary company, The Valley Electrical Supply Co., self-contained as to purchasing, financing and accounting and organized as the merchandising division of the parent company.

When they started the domestic load was one capable of immediate and intensive development. Here was a class of load—the mainstay of the company's business—which was, so a survey showed, not increasing at

a desirable rate. Only one answer was possible, and this:—The home must be thoroughly electrified and to bring this about they must facilitate and speed up the flow of electrical appliances into the hands of the consumers.

In the year 1921, ten years after the organization of The Valley Electrical Supply Co., they were called upon by that power company so to re-arrange their affairs that, while remaining a financially self-supporting and profit-producing unit of the parent company, they would henceforth actively and aggressively engage themselves in the work of building up the utility's domestic load.

At the end of the year 1924, the power company asked them to budget the departmental expenses for the coming year, not, however, in a lump sum, but in the form of a proposal in which they offered to do a specified part of the domestic load-building job for a unit sum for each kilowatt connected. This sum was based on the deficit resulting from their extensive educational, advertising and missionary work, costs on which had been very carefully kept during the preceding years.

In general, the plan of appliance merchandising and the principle underlying it may be expressed in a very few words: To conduct our business on a "live and let live" basis. This means that, while fully recognizing the importance and necessity of active participation in the field, they would not let this blind them to the equally great necessity of retaining the goodwill of all the merchandising branches of the electrical industry: the manufacturer, the jobber and the dealer. They decided to purchase their supplies from jobbers and to use the medium of all existing and available retail dealer outlets as the connecting link between themselves and the ultimate user, the domestic power consumer.

They soon reached an understanding with some of the dealers, whose numbers have since grown to 125, and they agreed to co-operate in the sale of both heavy duty and lamp-socket appliances. These dealers are the backbone and substance of the plan. Through them the company directs the unbroken flow of current-consuming devices into the homes and on to the lines of the power company. They have found their co-operation of inestimable value.

All heavy duty appliances are sold through the stores of the local dealers. In Fresno and Bakersfield, where Valley Electrical Supply has stores of its own, these share in the business written by the utility salesmen on a basis of equality with the other dealers. Salesmen and demonstrators are regular employees of the Valley Electrical Supply Co. They are paid a salary and a bonus based upon the kilowatts of connected load secured in their respective districts.

It is the duty of salesmen to assist co-operating dealers in the sale of heavy duty appliances, or to make these sales and then turn them over to dealers. After a sale has been made the utility salesman informs the purchaser of the name of the nearest dealer; the purchaser to indicate with whom he wishes to do business. Should the purchaser ask the salesman to place the order, the latter uses his best judgment in selecting a

dealer. At no time are the utility salesmen to take a commission, bonus or gift from a dealer for helping him in the making of sales. Prices quoted to dealers are: cash, f.o.b., Fresno.

These terms are made necessary by the low prices at which the material is being sold to the dealers. Dealers are not compelled nor urged to obtain their appliances from Valley Electrical Supply. They are at liberty to draw from their regular jobbers' stocks and to make with their suppliers their own credit and delivery agreements. Should a dealer wish to sell equipment on the installment plan but not want to carry the terms paper himself, the utility salesman helps him secure finance company connections. Credit will be given to company salesmen for all ranges, water-heaters and heavy duty cooking appliances sold within their respective districts, regardless whether or not they made the sale. The dealer makes his own credit and payment terms with purchasers—thus leaving The Valley Electrical Supply Co. and the power company out of the picture.

Educational work has caused the average return to the power company per kilowatt of domestic heavy duty cooking appliances installed to mount to $12.50 per year, as against an average of not over $6.50 for other utilities on the Pacific Coast.

As to rates:—combination cooking, heating and lighting prices charged by the San Joaquin Light and Power Corp., are amongst the lowest on the Pacific Coast. They are on a sliding scale and range as follows:

for the first 30 kw-hr.—5½c. per kw-hr.

for the next 120 kw-hr.—4c. per kw-hr.

for all over 150 kw-hr.—1½c. per kw-hr.

Service Charge—50c.

Lamp-socket appliances are sold in both Fresno and Bakersfield stores and in periodical stimulating sales campaigns through co-operating dealers over the entire system. Valley Electrical Supplydoes not purchase appliances in such large quantities that the over supply to the dealer endangers or kills all sales of his regular shelf stock during the campaign period. Instead, they encourage the dealer to estimate his needs conservatively and so that his stock of special appliances will have moved before the official end of the sale. By holding this special business down to about 10 per cent. of the dealer's average gross these campaigns, instead of being detrimental to his sales of regular shelf stock, will actually assist him in making sales from his nationally advertised list price appliances, on which he realizes a gross profit greater than he can earn on campaign appliances.

All campaign material is delivered to dealers either from The Valley Electrical Supply Co.'s own warehouse or from jobbers' stocks. Whatever part he left at the end of the sales period is taken back by them and full credit is allowed for these returns. This prevents dealers from using these special articles for the purpose of cut-price competition after the sale has run its course. At no time do they cut the price on a nationally advertised list price appliance, nor do they ever give a premium with any

such article, which in fact would amount to a discount.

When dealers want demonstrators or special sales women to attend their stores during special sales campaigns, they supply these from their headquarters staff whenever possible. The presence of these company employees in the dealers' stores is quite frequently the means of making the public realize that a friendly feeling exists between their local dealers and the utility.

In the consideration of this merchandising plan it should be remembered that the utility pays only for the domestic heavy duty appliance load added to its system and for that part of the small appliance load which accrues from the sale of the so-called stimulating appliances, distributed at regular intervals, through the stores of co-operating dealers. The increase in load which results from the sale of the many other domestic appliances by The Valley Electrical Supply Co. does not cost the power company one cent.

The figures given apply to the domestic load only and thus should only be compared with the expenses of other companies in acquiring load of that same character. Other utilities, in showing their new business expenses, make this item cover *all* classes of load, domestic, commercial, agricultural and industrial. In that way they are able to show a low unit of expense, since large blocks of power, other than domestic, are sometimes secured at but a small cost per kilowatt and the addition of this load at low cost naturally tends to depress the average unit cost of all new business written.

The Valley Electrical Supply Co. pays all expenses incident to a well conducted independent merchandising establishment, such as: materials and labor, salaries and commissions, advertising, accounting, depreciation, reserves for uncollectable accounts, injuries and damages, etc.

They are building up the power companies domestic load at a very rapid rate, increasing the same by nearly 100 kw-hr. per consumer from 1927.

The San Joaquin Light and Power Corp., the parent company, has been awarded prizes in the National Load Building Contests sponsored by the National Electric Light Association. As has been stated before, the growth of the domestic load has been a very steady one and its rate of increase, though rapid, was free from objectionable spurts and depressions.

It has already been stated that this plan of appliance merchandising has passed the test of all theories—that of workability. It was also mentioned that the company has retained the friendship and goodwill of the industry. The retention of this friendship of competitors as well as of collaborators has been the company's greatest source of satisfaction and is not to be considered as the least of the results which have been achieved through the adoption of the "Through the Dealer" Sales Plan.

(NOTE.—A very good illustration of this successful merchandising plan has been brought to our attention by the latest General Electric refrigeration figures. The Valley Electrical Supply Co. leads the country in percentage of increase over their quota.)

Consumers Billing and Control Accounts

By D. B. McColl, Manager, Walkerville Hydro-Electric System.

(Read before Accounting and Office Administration Session of Association of Municipal Electrical Utilities at Ottawa, June 25, 1931.)

IT is not the purpose of this Paper to attempt to explain the many underlying reasons for the more or less recent demand of better customer accounting methods for Public Utilities, particularly municipally owned systems. Neither is it the intention to attempt to discuss the relative merits of the various accounting systems at present in use, but simply to describe the billing methods now in use by the Walkerville Hydro-Electric System.

The Staff of our Billing Department is responsible for both billing and collecting consumers' accounts, there being no separate collection department maintained. The Staff consists of a Chief Billing Clerk and four assistants.

The entire work of the Department is divided equally, each clerk being allotted definite duties for which they are held responsible by the Chief Clerk. This arrangement has been found very satisfactory, as each Clerk knows exactly what his or her duties are, and it also enables the Chief Clerk to definitely place responsibility for errors or omissions of any kind. It also has a tendency to create a greater sense of responsibility on the part of the Staff, as each Clerk takes pride in seeing that his or her work is performed as neatly and accurately as possible.

Briefly, the work has been divided as follows:—

(a) *Chief Billing Clerk* is responsible for general supervision of the work of both billing and collections, checking daily and monthly balances, etc.

(b) *The Operator* is responsible for all billing and must at the termination of each day's work, turn over to the Chief Billing Clerk the day's Billing Proof Sheets properly balanced.

(c) *The Cash Posting Clerk* is responsible for posting all payments to the Ledger Cards and must at the termination of each day's work turn over to the Chief Clerk a Proof Sheet of the day's cash postings properly balanced.

(d) *The Meter Record Clerk* is responsible for all meter and load records and must at the termination of the day's work turn over a proof sheet of the day's work properly summarized.

(e) *The Junior Clerk* is responsible for all the miscellaneous work of the Department, including the counter work, completing new consumers' ledger and meter cards, address plates, etc.

The sundry work of the Department such as typing, checking delinquent accounts, etc., is divided

as equally as possible between the various members of the Staff.

We have approximately 8,000 active revenue accounts, divided between the five systems operated from this office as follows:—

	Domestic	Commercial	Power	Total
Walkerville	2,581	354	102	3,037
East Windsor	2,817	403	43	3,164
Riverside	1,127	56	10	1,193
Tecumseh	843	53	3	539
St. Clair Beach	51	9	2	62
Total	7,059	776	160	7,995

The commercial lighting and power meters are read monthly and the domestic meters bi-monthly, under the cycle billing plan. Every effort is made to see that all meter readings are taken each billing period, and unread meters, as a rule, do not exceed one-half of one per cent.

Each Municipality is treated as a separate district, which gives us a total of five districts for each class of consumer. No necessity has been found for dividing the larger municipalities into districts, as no difficulty has been experienced in accurately balancing consumers' accounts at the end of each billing period, as a system of daily balancing has been inaugurated which has proven very successful. This will be fully described later on.

A Burroughs Billing Machine has been in use for approximately 18 months, and is used under the combination bill and ledger plan of customer accounting, using individual ledger cards. The five main forms used are the ledger card, the bill, the daily billing proof sheet, the daily proof sheet of cash posted and the monthly revenue sheet. A copy of each of these forms is attached, which I believe will be self explanatory.

Both sides of the ledger card are ruled identically, making possible a four years' continuous record. The space at the top is used for showing consumers' name, address, account number, etc., and the space at the bottom is used for the listing of all information pertaining to meters, connected loads, service calls, etc.

The bill form is self explanatory. You will note that it shows the date of the reading, the present and previous readings, the consumption, service charge, the amounts of the first and second rates, separately, and the gross and net amount of the account. The rates are shown on the back of the bill, so that the extensions can be checked by the customer.

The Daily Billing Proof Sheet, which is a carbon copy of all accounts billed, gives a complete summary of each. These sheets at the end of each day's work are carefully proved.

The Daily Cash Proof Sheet is also self-explanatory and is carefully balanced at the end of each day's work, and will be fully described later.

Meter Reading Sheets are arranged in street order number and are locked into a binder, making this order permanent. Ledger cards and addresso-

graph plates are filed in identical order with the reading book, thus eliminating any sorting at the time of billing. Ledger cards are carefully filed under the supervision of the Chief Billing Clerk, and may be withdrawn on requisition only. This practice has almost entirely eliminated the lost or misfiled card.

All bills are delivered by our own force directly to the premises served, except when requested otherwise by the customer. Consumers' accounts are opened upon receipt of meter installation report, to which is attached a copy of the customer's application for service, at which time an addressograph plate is made and applied to a ledger card upon which is entered the meter installation record. The card is then regularly filed in readiness for the initial billing.

As previously mentioned, a Burroughs Public Utility Machine is used in our Billing Department. This machine types the bill, ledger card and billing proof sheet at one operation. The card and the bill receiving original impressions, the proof sheet being a carbon copy of the bill. The machine is so constructed that there is a mechanical assurance that certain operations are properly performed. It is equipped with a lock that prevents a change in the set up during an automatic repeat print operation, thus assuring that the charges showing on the bill are identical to those shown on the cashier's stub. Each morning the operator receives the previous day's meter book, addressed bill forms and corresponding ledger cards, all of which are in the same order. She first puts in the present date and both the present and previous readings, then the consumption and service charge, followed by the consumption charge at the first and second rates and the gross and net amounts, which she calculates either mentally or by referring to a chart. The next step is to put in any unpaid balance as arrears followed by the posting of sundry debits, if any, and then to show the total charge which is, of course, a machine operation.

The standard production rate is set at 800 bills per day per operator. Our actual production has on certain days come very close to this figure.

Bills are proven for accuracy by the operator and checked by the Chief Clerk by means of balancing the Proof Sheet. A detailed description of this operation would be too lengthy and too hard to follow without having a sheet before you, but it may be said in a general way, that the proof rests in balancing the amount obtained by applying the rates to the total consumption of the sheet and to the total revenue of the sheet. This, of course, necessitates grouping kilowatt hours sold at the various rates, grouping the service charge and making corrections for certain rate peculiarities such as minimum bills, etc. Any bills found to be in error are immediately corrected by the Operator. The balanced billing proof sheet not only certifies to the accuracy of the billing, but also supplies the information for trial balance and revenue distribution, and also serves as a basis of all our statistical data.

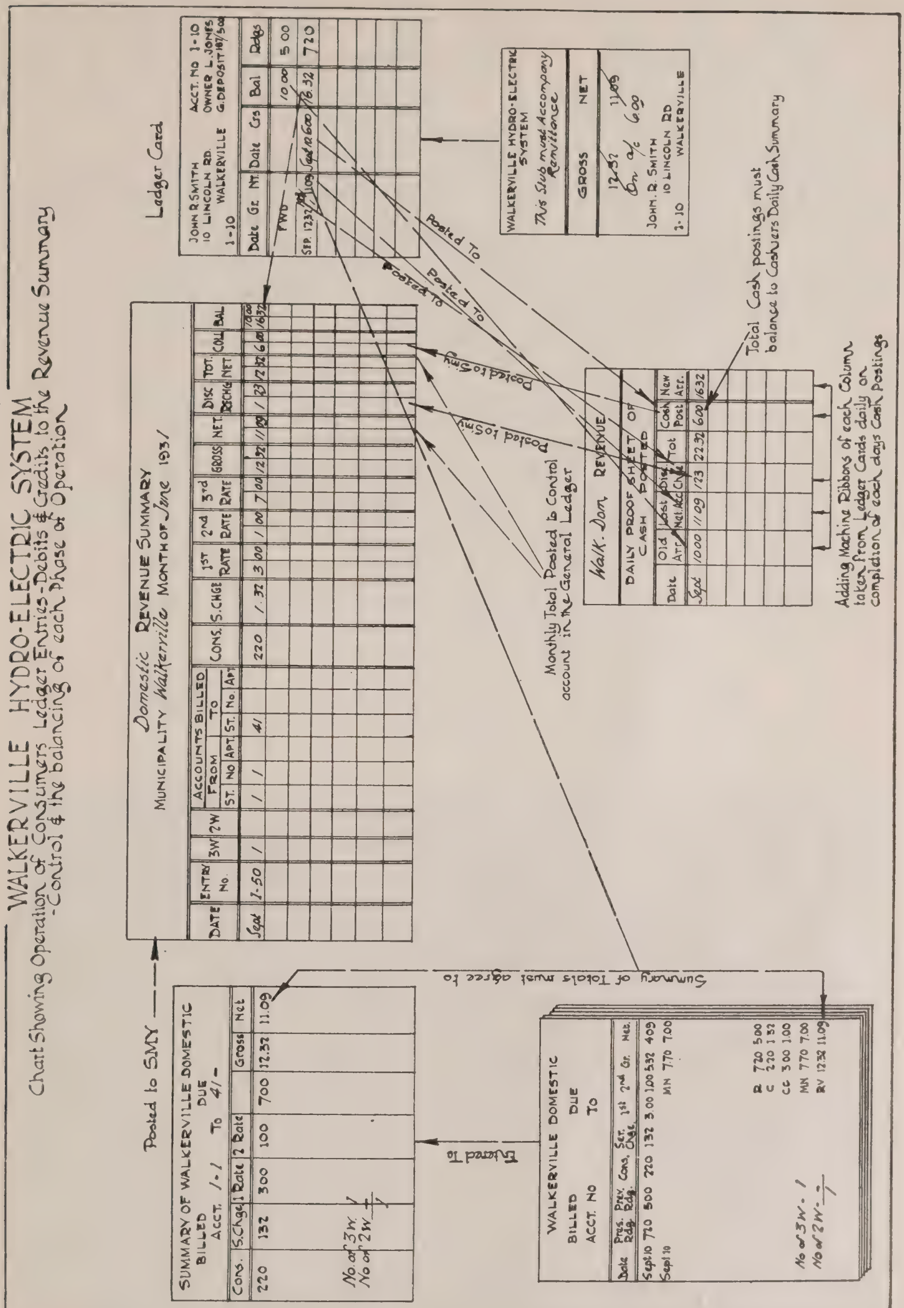
It is our practice to post all cash received on the following day. The bills are paid either in person or by mail direct to our Cashier, and to

Banks through the Municipalities served. In order to post the cash the day following its receipt, it is necessary to sort stubs and take out the ledger cards, the first thing the following morning, so that the posting can be completed, if possible, before noon. At the end of each day's posting, totals are taken separately of the old arrears, the last net accounts and the discounts recharged. The completed total of these three items is subtracted by the total of the day's cash postings, so that the net result must agree with the total of the unpaid balances outstanding on the ledger cards for that particular day. These totals are then posted on the Daily Proof Sheet of cash posted and passed to the Chief Clerk for checking purposes.

The totals as shown by both the Billing Proof Sheet and the Daily Cash Proof Sheet are posted daily by the Chief Clerk to the monthly revenue summary, which at a glance shows the total billing and collections for the day and for the month, and also the total of unpaid accounts at the end of each day. This sheet also shows the number of accounts billed, total consumption and revenue at the various rates, which is at all times available in permanent form for statistical purposes.

Forfeited discounts on delinquent accounts are picked up about ten days after the discount date expires, and the ledger cards are then balanced against the balances shown on the revenue summary sheet. This is a very simple operation, requiring the listing of outstanding accounts on the ledger cards, the total of which must agree with the balance shown on the summary sheet, and it is rarely that it takes more than a very few hours to balance even our largest districts of as many as 2,500 accounts.

At this point collection work breaks into the picture, as the Chief Clerk when posting discounts forfeited, also establishes a delinquent list simply by setting aside all cards showing arrears. A gentle reminder is then sent the customer asking for payment within ten days. At the expiration of this period all remaining delinquent accounts are sent a final disconnection notice, advising that the service will be discontinued if the account is not paid within seven days. At the expiration of this period disconnection notices are issued to the Service Department to disconnect all services in arrears, unless arrangements have been made in the meantime by the customer for a short extension. It might be advisable to point out that through experience we have found that collections can be dealt with much more successfully, both from our own and customers' standpoint, if the same are followed up directly after the discount date expires at the end of each billing period, as it has been clearly proven that accounts which are allowed to remain outstanding over a period of months, in the final analysis usually results in added difficulties for the consumer through not being able to pay a four or six months' account promptly, and necessitates disconnection of service with added expense to both the utility and the consumer, and it is rarely that leniency in extending payments of accounts, under the above conditions, is appreciated by the consumer, who naturally forgets


WALKERVILLE HYDRO-ELECTRIC SYSTEM
Chart Showing Operation of Consumers Ledger Entries-Debits & Credits to the Revenue Summary -Control & the balancing of each Phase of Operation
Ledger Card
Domestic Revenue Summary
Municipality Walkerville Month of June 1931
Daily Proof Sheet of Cash Posted
Walk. Dom. Revenue
WALKERVILLE HYDRO-ELECTRIC SYSTEM
This Stub must Accompany Remittance
Posted To
Posted to Smy
Posted to SMY
Entered To
Summary of Totals must agree to
Monthly Total Posted to Control account in the General Ledger
Total Cash postings must balance to Cashiers Daily Cash Summary
Adding Machine Ribbons of each Column taken from Ledger Cards daily on completion of each days Cash Postings
SUMMARY OF WALKERVILLE DOMESTIC
WALKERVILLE DOMESTIC

any previous favours shown him when it is finally found necessary to disconnect his service.

I would like to point out some of the advantages derived from the use of mechanical billing, which has, without doubt, given us improved production at reduced costs.

First — Neatness — Better looking bills and more legible internal records.

Second—Accuracy—The bill, cashier's coupon and ledger record cannot differ; the consumption is proved to be the difference between the readings; the extension of the quantity used by the rate applicable is guaranteed and the revenue is certain, because it is the amount of each bill, added as it is printed.

Third—Control—There is a stipulated total of what bills have been sent out and any error or omission, can be easily detected because cash received plus uncollected accounts must check to the amount of bills printed.

Fourth—Speed—The machine used can prepare the bills, stubs, ledgers, and revenue statistics at a production of from 700 to 800 accounts per day.

In conclusion, I would like to draw your attention to the attached graph, which outlines the forms and procedure used in our Billing Department. It is realized of course that only the high spots of customer accounting have been touched upon in this Paper. A most cordial invitation is extended to all who may be interested in seeing the system in actual operation, to pay a visit to our office at any time.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Some Interesting Aspects of the Hydro System

Including an Historical Review of its Policies and Achievements and a Consideration of the Lessons to be Learned Therefrom.

By F. A. Gaby, D.Sc.,Chief Engineer.

(*Address to Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Ottawa, June 26, 1931.*)

IN addressing, on an occasion like this, an audience composed of those who are so familiar with electrical activities in this Province, it may seem strange to undertake to present an historical review of the work of the Hydro-Electric Power Commission of Ontario.

I am not, however, undertaking to deal with this subject purely from the standpoint of its history, but rather from the standpoint of what these historical circumstances contain by way of lessons for those of us who are jealous for the present and future welfare of the Commission and the associated hydro-electric utilities. We shall see that the history of Ontario's Hydro undertaking constitutes a real guarantee for its continued stability and growth.

While there are in this audience many who are familiar with the historical incidents to which I shall refer, yet there are many newcomers upon the Hydro Commissions to whom, I believe, it will be profitable to have their attention directed to various circumstances which characterized the early work in connection with our Hydro undertaking. The work of the Hydro-Electric Power Commission and the associated utilities is unique and only through a good understanding of its early history and of the basic principles upon which it is founded can there be an intelligent guarding of this undertaking through which such benefit has been conferred upon Canadian commerce and industry.

On all sides, we are having our

A special request has been made for the publication of Dr. Gaby's address comprehensively reviewing the work of the Commission. There is published in this issue the first of three instalments which will present the complete address.

CONTENTS

Vol. XVIII **No. 8**

August, 1931

attention directed to the exceptional economic conditions which are world-wide in their effects upon expansion in practically all lines of financial, commercial and industrial activity. It is not necessary for us here to do more than ackowledge the fact that we are confronted with these economic conditions.

Curtailment in the general commercial and industrial fields has unquestionably caused special concern to those who know that progress cannot be maintained in the absence of certain basic essentials. To a community of increasing industrial status such as is Ontario, the matter of ample low-cost power supplies is one of these essentials for expansion, and to those who are responsible for their provision, the present period is one in which a substantial measure of foresight and faith must be exercised because power supplies must be planned and provided for well in advance of the time when they will be put into actual use.

Now, in this connection the Hydro-Electric Power Commission of Ontario has made arrangements to supply the power needs of co-operating municipalities for several years in advance, and there are those who point to these provisions as being unjustifiable and in excess of future requirements. It has seemed to me, therefore, that it would be profitable to review some of the prominent incidents in connection with the development of Ontario's hydro-electric undertaking in order that we may perceive how, step by step, somewhat corresponding conditions have previously had to be coped with, how similar criticism was offered and also how, notwithstanding opposition of one kind and another to programs proposed and consummated, the Hydro-Electric Power Commission's work as a whole has steadily progressed. If this be the case, there is in it a strong element of encouragement and hope for us all in the fact that history has a way of repeating itself, and may be expected to do so in the case of the Hydro-Electric Power Commission and the associated electric utilities. In any event, the Commission and its executive officers have proceeded on the basis of confidence in the development of the Dominion of Canada and of the Province of Ontario, and in the belief also that the present period of depression, like those that have preceded it, will sooner or later give place to a general business revival, accompanied by an expansion which, approximately within the period assigned, will absorb the power supply provided for the future requirements of the citizens of Ontario.

ONTARIO'S NATURAL ADVANTAGES

We shall commence with a brief historical review beginning with the present century. Prior to 1900, it

was becoming more and more recognized that the many natural advantages of the Province of Ontario with its important resources of agricultural areas, forests, minerals and other raw materials, could be utilized to place the Province in an advantageous position in the realm of commercial and industrial activity. In this connection, it was recognized, however, that Ontario should have a supply of low-cost power. At this time, high-tension transmission of electrical energy was receiving much attention, and it was believed that it would be economically possible to transmit electrical energy over extensive distances from places where large amounts of water power could be developed. With commendable foresight the Toronto Board of Trade gave definite attention to these problems and, in 1900, a special committee of that organization submitted a report directing attention to the abundant supply of hydro-electrical energy that could be developed from the Niagara River. Citizens in other municipalities were directing attention to the same problem and it was evident that there was a good basis for co-operative municipal action if a suitable program were devised.

Early History of the Undertaking

Preliminary Investigations

Some of you will recall how the interest of communities and industrialists was stimulated through public meetings and by other means. The result of this general pioneer work was that in 1903 the Government of Ontario provided legislation under which interested municipalities could appoint a commission to investigate and report upon questions relating to the supply and distribution of power. The municipalities of Toronto, London, Brantford, Stratford, Woodstock Ingersoll and Guelph combined to act through an organization known as the Ontario Power Commission. This Commission, composed of prominent men in Western Ontario, Messrs E. W. B. Snider, P. W. Ellis, W. F. Cockshutt, The Hon. Adam Beck and Prof. R. A. Fessenden, conducted a public investigation and, in 1906, presented a report entitled "Official Report of the Ontario Power Commission 1906". It reviewed the whole subject in its relationship to Ontario's needs and emphasized the practicability of procuring from the development of the Niagara River, power which could be transmitted to Ontario municipalities at favorable cost. This report includes estimates of the cost of new development, at Niagara Falls, plus estimates on transmission and distribution to the municipalities for various amounts of power.

The Provincial Government, in 1906, by special Act, provided for the creation of the Hydro-Electric Power Commission of Ontario, and in 1907, by further legislation, strengthened and extended the powers of the Commission. The later legislation provided the means whereby all groups of municipal electrical undertakings would be under the guidance and supervision of a single commission rather than, as would have been possible under the earlier legislation, for various groups of municipalities to operate through separate commissions. Furthermore, it provided a sound means of financing.

In view of the fact that your Association is now convened in the city of Ottawa, it is of especial interest to note that the legislation creating the Commission, which had been prompted primarily by the possibilities of securing power for the municipalities that could be served from Niagara Falls, nevertheless found its first field of activity in the actual provision of power for municipal use in connection with the city of Ottawa. Owing to the necessity of arranging for co-operation between a number of municipalities in the case of the Niagara system, and also to the time required to design and build the necessary transmission network, by-laws on the Niagara system were not passed until 1908, and power was not delivered until 1910. In the meantime, the city of Ottawa embraced the opportunity afforded by the creation of the Commission, and, in 1907, passed a by-law for the purchase of power through the Commission, receiving actual delivery of power in the same year. The contract provided for the ultimate delivery of 20,000 horsepower delivered within the municipality, at the low price of $11.00 per horsepower.

Systems of the Commission

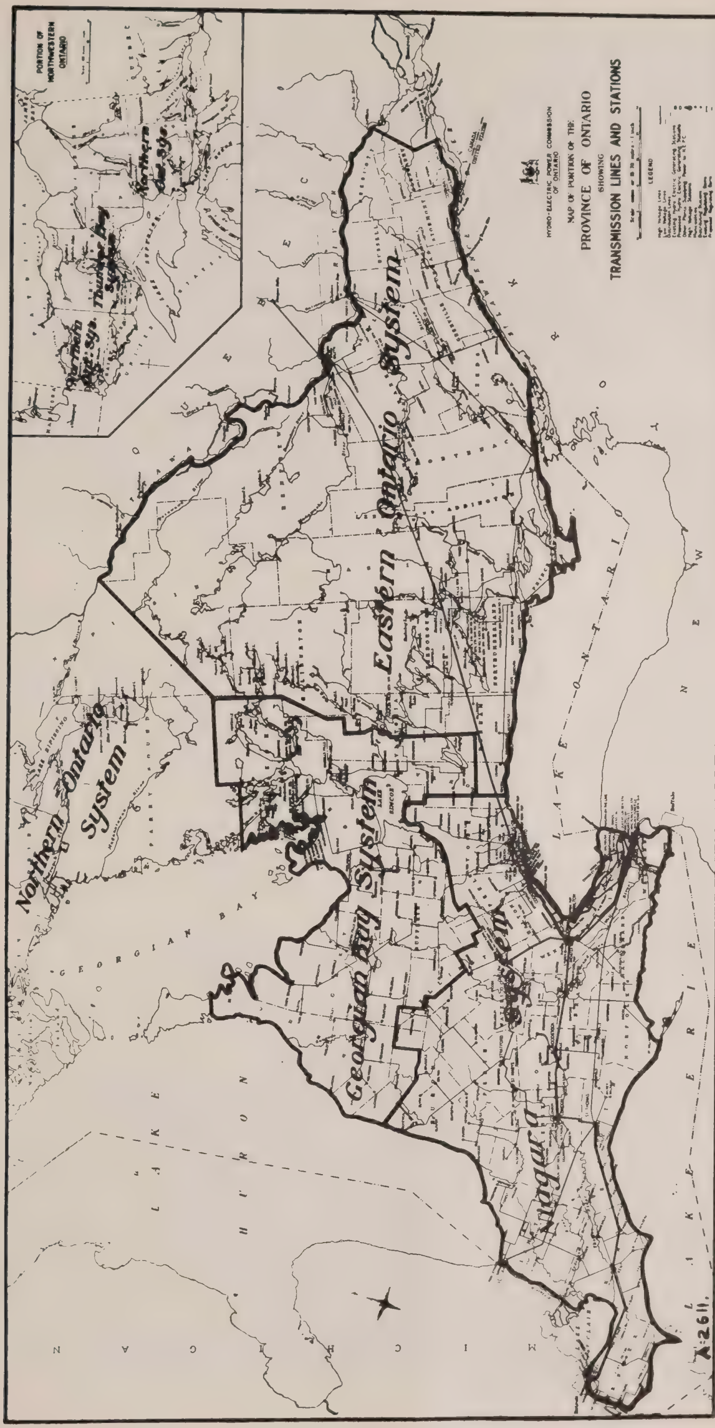
At the present time the co-operating municipalities are organized in five systems, illustrated on accompanying map, the Niagara, the Georgian Bay, the Eastern Ontario, the Thunder Bay and the Northern Ontario systems; historically, most of these systems are consolidations of smaller groups or systems previously existing under other names.

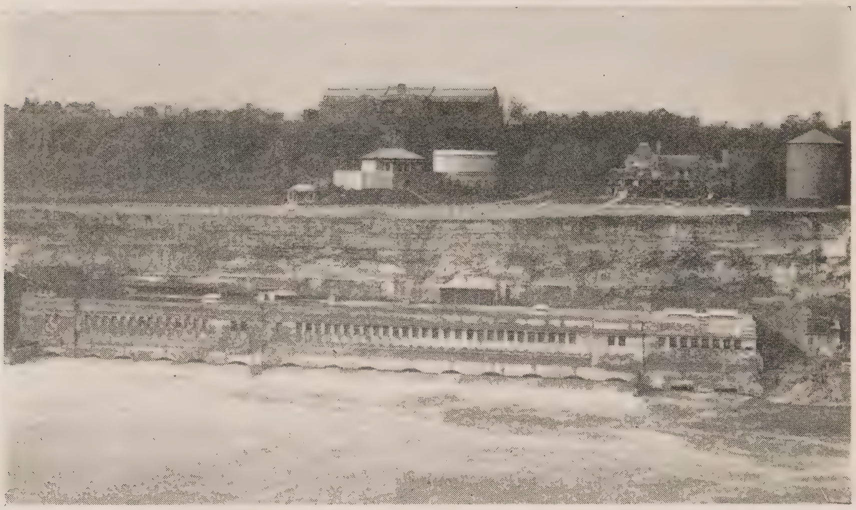
Niagara System.

The initial steps in the actual formation of the Niagara system were taken in 1908 when the Commission entered into a contract with the Ontario Power Company for the delivery progressively to the Commission of power up to 100,000 horsepower, and 13 municipalities passed by-laws authorizing their officials to enter into contract with the Commission for a supply of electrical power from Niagara Falls.

Previously, on the 13th of July, 1906, the Hydro-Electric Power Commission had asked four Companies, the Canadian Niagara Power Company, the Ontario Power Company, the Electrical Development Company and the Erie and Ontario Development Company, to submit tenders for the supply to the Commission of electric power. The last mentioned Company apparently did not tender. The Electrical Development Company replied that owing to its works being then under construction the total expenditure was indeterminate and that it was unable satisfactorily to tender.

The Canadian Niagara Power Company tendered on August 13th, 1906. The Ontario Power Company tendered during 1906. The various tenders and representations were considered with great care and after lengthy negotiations the contract on the 12th of August, 1907, was awarded to the lowest tenderer—the Ontario Power Company. This was followed by an amending agreement on the 19th of March, 1908, under which contracts the terms broadly stated, are $9.40 per horsepower for power


HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO
MAP OF PORTION OF THE
PROVINCE OF ONTARIO
SHOWING
TRANSMISSION LINES AND STATIONS
LEGEND
PORTION OF NORTHWESTERN ONTARIO
Thunder Bay System
Northern Ontario System
Eastern Ontario System
Georgian Bay System
Niagara System
GEORGIAN BAY
LAKE HURON
LAKE ONTARIO
LAKE ERIE
QUEBEC
NEW YORK
MICHIGAN
A-2611

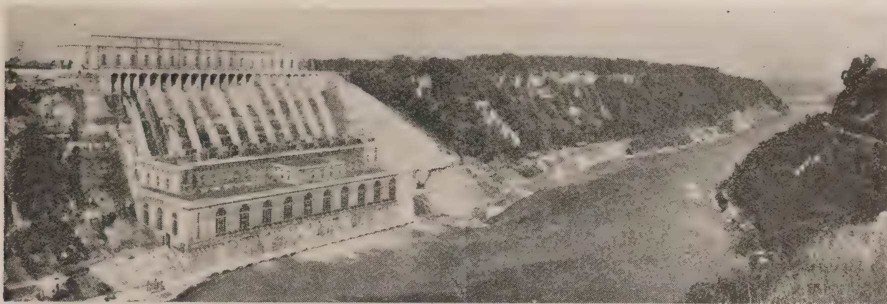


Ontario Power Plant at Niagara Falls

at 12,000 volts until 25,000 horsepower are taken, and then $9.00 per horsepower up to a total of 100,000 horsepower. The Hydro-Electric Power Commission then proceeded to construct a net work of transmission lines in order to convey Niagara Falls power to the municipalities which first came into partnership, and by the end of 1910 power was being distributed to several municipalities. The initial capital expenditure to serve some twelve municipalities amounted to $3,600,000.

The small initial load of less than 1,000 horsepower increased rapidly until in 1914 it was 77,000 horsepower, and by 1915 the Commission reached the limit of its contract with the Ontario Power Company for 100,-

Electrical Development Generating Station at Niagara Falls



Queenston Power House and Niagara River from U.S. Side

000 horsepower. The Commission then arranged for an additional 50,000 horsepower from the Canadian Niagara Power Company, the final price of which was fixed at $15.00 per horsepower at the generating terminals, and from the Toronto Power Company of over 25,000 horsepower at varying prices from $15.00 up. Subsequently, in August, 1917, it purchased outright the Ontario Power Company with its plant capacity of 160,000 horsepower—which was increased to 180,000 horsepower in 1919—and, in December, 1920, acquired the Toronto Power Company, with its plant of over 125,000 horsepower capacity. In 1920 the demands of the municipalities had increased to 356,000 horsepower. In view of this rapid increase and the necessity of providing for future demands, recommendation was made for legislation, which was enacted, authorizing the Commission to construct the Queenston-Chippawa development in 1917. The first unit of this development was placed in commercial use in January, 1922; additional units were successively installed in accordance with growth in load until in December, 1925, the ninth unit was installed, bringing the capacity of the development up to about 550,000 horsepower. In 1930, a tenth unit was installed, which gives some latitude in spare capacity to be used in the event of the shutting-down of any unit for examination or repair.

Provision for Ownership of Power Plant and for the Purchase of Power

In the early period of the Commission's operations, its contractual relationship to the municipalities in

NIAGARA SYSTEM

MAXIMUM POWER AVAILABLE—HORSEPOWER—JUNE, 1931

H.E.P.C. Generating Plants		Power Purchased	
Ontario Power Co.	183,650	Canadian Niagara Power Co.	30,000
Toronto Power Co.	147,450	Gatineau Power Co.	250,000
Queenston	532,790		
Dominion Power & T. Co.	73,900		
Total Generated	937,790	Total Purchased	280,000

TOTAL........ 1,217,790

Interior view of Queenston power house

the Niagara district provided only for the purchase of power. Under the legislation in force in 1916 the Ontario Government contemplated proceeding with the construction, as a government proposition, of the Queenston-Chippawa development, the resulting power to be sold through the Commission to the municipalities. Such a program, however, was not favorably regarded by the municipalities who desired some arrangement whereby they could construct and own their power developments. Preparatory to securing new legislation to accomplish this end, it was decided that the municipalities, in 1917, should submit to their ratepayers entitled to vote on money by-laws, a plebiscite to ascertain whether they

> "are in favour of having the Municipality develop or acquire through the Hydro-Electric Power Commission of Ontario, whatever works may be required for the supply of electric energy or power in addition to such electric power as is already supplied or can be obtained under the existing contract with the Hydro-Electric Power Commission of Ontario."

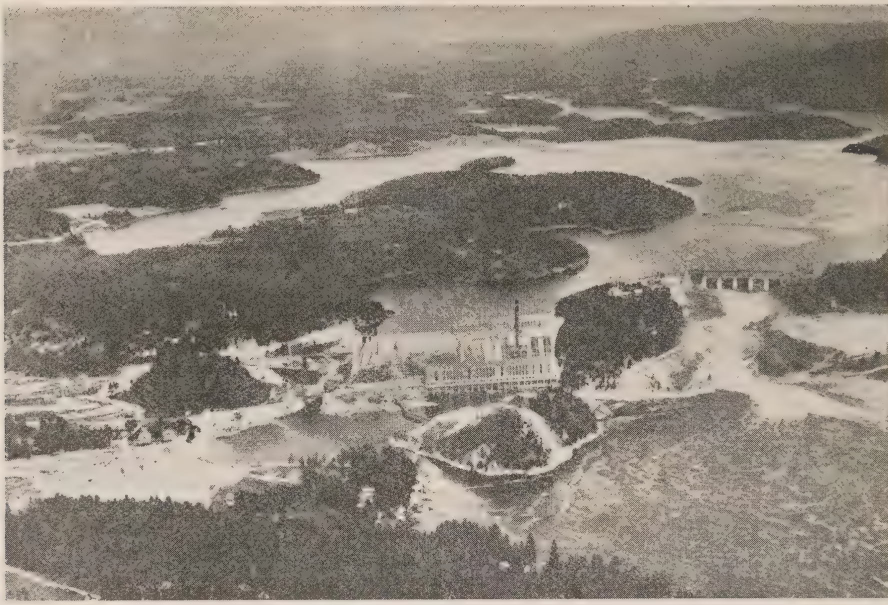
The result of this vote was that 64 municipalities passed the by-law. Only one municipality rejected it. The vote was 42,013 for and 5,550 against. Subsequently, the Ontario Legislature passed *The Ontario Niagara Development Act, 1917*, which definitely conferred upon the Commission "all the powers set out in Section 3 of *The Ontario Niagara Development Act*"—which had been passed the previous year,—"for the construction and operation of the works . . . for the supply of electrical or pneumatic power or energy to municipal corporations which have heretofore entered or may hereafter enter into contracts with the Commission for the supply of electrical or pneumatic power or energy from the Niagara River or Welland River."

Furthermore, the Act of 1917 specifically states that the Commission is to hold the power development works as trustee for the municipalities. This Act in Section 6 states:

> "It is hereby declared that the Commission is to be a trustee of all the works constructed or acquired under the authority of this Act for the municipal corporations which have heretofore entered or may hereafter enter into contracts with the Commission for a supply of electrical power or energy from Niagara Falls or the vicinity, . . ."

And Section 7 empowers the Commission to make contracts for the sale of power to companies and apply the net profit, if any, to the cost of the power works constructed by the Commission—and thus to the benefit of the co-operating municipalities.

Soon after the Queenston-Chippawa plant was in operation, the Commission recognized the fact that the power would probably soon be marketed, and that other supplies must be arranged for in the near future. In view of obstacles preventing at the time the development of additional power from the Niagara, the St. Lawrence and the Ottawa watersheds in Ontario—subjects to which I shall presently refer more fully—and regarding utilization of Canadian hydro-electric resources as



Aeroplane view of the Paugan Development of the Gatineau Power Company

being preferable to dependence upon imported fuels, the Commission in 1926 contracted for 260,000 horsepower from the developments on the Gatineau River in Quebec, and in 1929, an undertaking was entered into for the taking of 250,000 horsepower from the Beauharnois interests on the St. Lawrence River; in 1930, 125,000 horsepower from the MacLaren Company on the Lievre River, Quebec, and in 1929, 96,000 horsepower from the interests owning the Quebec half of the Chats Falls development, in addition to which, other plants had previously been acquired by the Commission. The Niagara system, as it exists to-day, includes the areas formerly served by the Essex County system, the Thorold system, the Ontario Power Company, the Toronto Power Company and its subsidiaries, and certain smaller networks. The Dominion Power and Transmission system will also shortly be incorporated. These circumstances insure, in so far as the Niagara system is concerned, that the municipalities have control, without competition in the supply of electrical energy within this area.

Georgian Bay System

Under what is now known as the Georgian Bay System, are consolidated transmission networks and systems of municipalities formerly known as the Severn, Eugenia, Wasdells and Muskoka systems, and to these have recently been added the small power developments and systems at Bala and also properties acquired from the Foshay interests in Bruce county.

The Severn system, first known as the Simcoe system, was initiated in July, 1911, with 200 horsepower purchased by the Commission from the

Simcoe Railway and Power Company for delivery to the municipalities of Midland and Penetang. By 1913 the Commission was serving seven municipalities in this system and the load was some 1,200 horsepower. In 1914, the Commission acquired by purchase for the sum of $435,000 the properties of the Company, including the Big Chute power development on the Severn River.

The Wasdells development on the Severn River, the first plant constructed by the Commission, was completed in September, 1914, and supplied power to the Wasdells system. The second development constructed by the Commission was that at the Eugenia Falls site on the Beaver River, and this served the Eugenia system. Other properties were constructed and acquired by purchase, until to-day in its Georgian Bay system supplying the district surrounding Georgian Bay and Lake Simcoe and extending as far north as Huntsville, the Commission has made provision for the electrical needs of the citizens of this important district in a manner that has ensured its development so far as low-cost power can contribute to it.

Eastern Ontario System

In 1916, the Province of Ontario acquired by purchase the group of properties formerly controlled by the Electric Power Company, Limited, which properties constituted the nucleus of the Central Ontario and Trent system and also the Nipissing system. These properties in the same year were handed over by the Province to the Commission as trustee for the Province until such time as adjustments could be made enabling transfer to the municipalities. In 1929, the legislature made provision whereby the properties were handed over to the municipalities, with full ownership, the Commission on behalf of the municipalities acting as trustee in the generation and transmission of power. These systems have been continuously enlarged in order to meet the growing needs of the territories served, and the Central Ontario and Trent system now comprises the chief district of what is now known as the Eastern Ontario system. As in the case of the Georgian Bay system, the Eastern Ontario system is a consolidation, its component parts being formerly known as the Central Ontario and

GEORGIAN BAY SYSTEM

MAXIMUM POWER AVAILABLE—HORSEPOWER—JUNE, 1931

H.E.P.C. Generating Plants	
South Falls	5,200
Trethewey Falls	2,300
Bala Plants	700
Bruce District	1,215
Hanover and Maple Hill	600
Eugenia	7,300
Big Chute	5,700
Hanna Chute	1,500
Wasdells Falls	1,200
	25,715

POWER PURCHASED

From Niagara System as required up to 5,000 horsepower.

Trent system, the St. Lawrence system, the Rideau system, the Ottawa system, and the recently acquired Madawaska system. These consolidations have effected substantial economies of benefit to each municipality and district in the systems.

Power supplies for the Central Ontario system were obtained from several hydro-electric developments on the Trent Canal system; for the St. Lawrence system by purchase from the Cedars Rapids Transmission Company; for the Rideau system from plants on the Mississippi River; for the Ottawa system by purchase from the Ottawa and Hull Power Company, and for the Madawaska system from its own plants on the Mississippi and Madawaska Rivers. For the consolidated systems these sources of power are now supplemented by power purchased from the Gatineau Power Company and transmitted to the several systems on a special high-tension network.

Thunder Bay System

In the Thunder Bay system, which includes the Lake-head cities of Port Arthur and Fort William, there has, since 1909, when this work was commenced with 5,000 horsepower purchased from the Kaministiquia Power Company at $15.00 per horsepower, been a steady and satisfactory development. In this important area, during recent years, power has been made available in large amounts to develop more particularly the pulp and paper and mineral resources. The chief sources of power supply for the Thunder Bay system are now the important power sites of the Nipigon River of which two, the Cameron Falls site and the Alexander site, have already been developed by the Commission. The Cameron Falls site with an installation of 75,000 horsepower and the Alexander site with an installation of 54,000 horsepower, rank, in point of magnitude of plants constructed by the Commission, next to its Queenston-Chippawa development but will, of course, be exceeded in capacity by the new Chats Falls development on the Ottawa River.

EASTERN ONTARIO SYSTEM

MAXIMUM POWER AVAILABLE—HORSEPOWER—JUNE, 1931

H.E.P.C. Generating Plants		Power Purchased	
Trent River Plant—			
Dams 2, 5, 11, 18 and 30	14,535	Gatineau Power Co.	18,000
Heely Falls	12,060	Ottawa & Hull Power Co.	20,000
Campbellford, Dam 9	4,500	Cedar Rapids Power Co.	7,500
Ranney Falls	9,650	Rideau Power Co.	487
Meyersburg	6,430	M. F. Beach Estate	375
High Falls	2,400		
Carleton Place	429		
Galetta and Calabogie	4,800		
Total Generated	54,804	Total Purchased	46,362

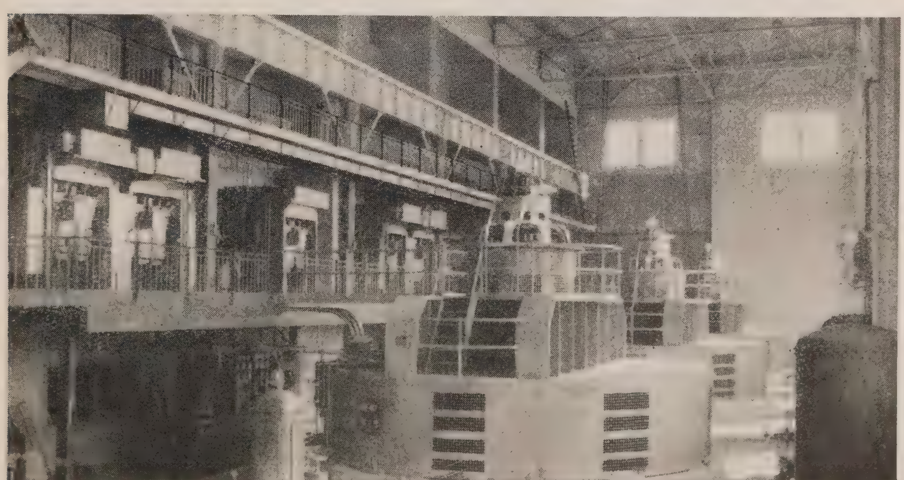
TOTAL........... 101,166

Alexander Development, view of power house from downstream side, all river flow passing over spillway.

Northern Ontario System

During recent years the Commission has given further special consideration to the problem of providing satisfactory electrical service to the municipalities and industrial organizations of northern Ontario, and in this connection has formed its Northern Ontario system.

At the present time this system comprises three independent districts, the Nipissing district, the Sudbury district, and the Patricia district. The Nipissing district served by three hydro-electric plants has been operated by the Commission for some years as the Nipissing system. The Sudbury district was formerly served by the Wahnapitae Power Company, which the Commission acquired in 1929. This also is supplied from three hydro-electric generating stations and service is given to Sudbury and several mines adjacent thereto. In the Patricia district the Commission has constructed a development at Ear Falls at the foot of Lac Seul



Interior view of power house, Alexander Development.

Stinson Generating Station, Sudbury District

NORTHERN ONTARIO SYSTEM

MAXIMUM POWER AVAILABLE—HORSEPOWER—JUNE, 1931

H.E.P.C. Generating Plants		Power Purchased for Emergency	
Nipissing	2,346	Abitibi	1,500
Bingham Chute	1,200		
Elliott Chute	1,800		
Ear Falls	5,000		
Wahnapitae	12,050		
Total Generated	22,396		
TOTAL	22,396		

on the English River, which will serve the mining district of Red Lake.

General Growth of the Organization

Since 1910, the Commission's transmission networks have extended rapidly both by construction of new lines and by the acquisition of existing transmission networks. The main transmission lines of the Commission now aggregate about 5,000 miles in length, and include more than 1,100 miles of 110,000-volt line and 400 miles of 220,000-volt line. In addition, the primary lines serving rural power districts now exceed 7,000 miles and increased at the rate of 1,800 miles for the year 1930.

The eleven original municipalities to which the Commission in 1910 supplied electrical service, including Ottawa, Port Arthur, and nine municipalities in the Niagara system, were rapidly added to, until in 1915 there were 130. In 1920, there were 263. In 1925, the number had reached 436, while at the present time the Commission is supplying electrical service to about 685 municipalities. This

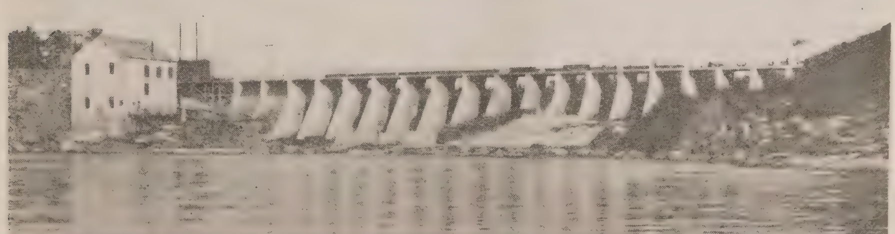
McVittie Generating Station, Sudbury District

number includes 27 cities, 92 towns, 255 villages and police villages, and 311 townships. With the exception of some 12 suburban sections of townships known as voted areas, the townships and about 80 of the smaller villages are served as parts of 160 rural power districts.

To-day, including power exported under long-term agreements entered into by certain power companies before their acquisition by the Commission, the Hydro-Electric Power Commission is distributing more than 1,250,000 horsepower. The bulk of this power comes from 37 water power plants which the Commission operates. With new plants in process of development and additional power to be supplied under contract, the Commission has now provided for a total power supply of about 2,000,000 horsepower.

History a Guide for the Future

Now, as I stated at the commencement of our present discussion, I have in mind to show that it has been necessary for the Commission to appraise future power demands well

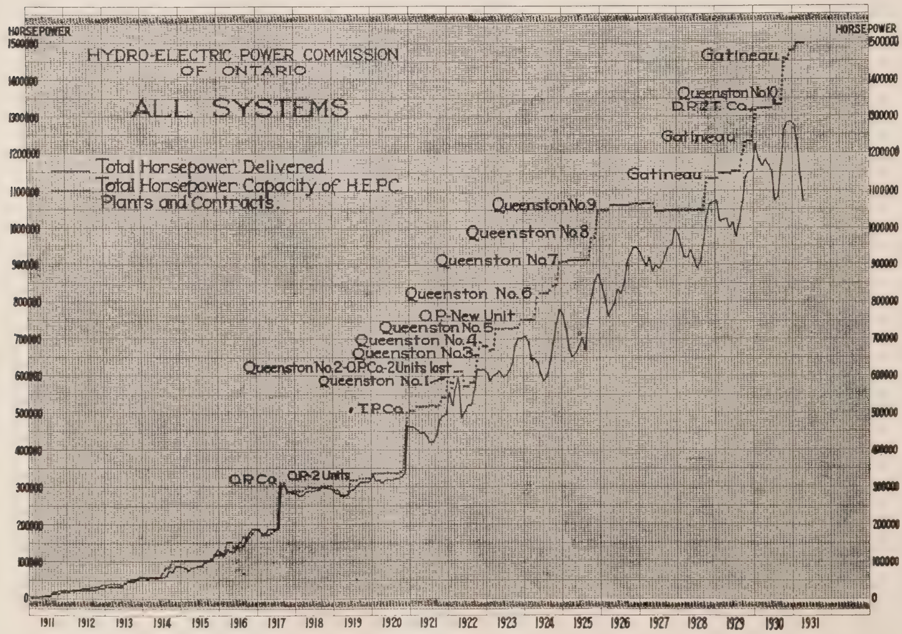


Development at Ear Falls on the English River

in advance of their materialization, in order to provide the necessary sources of supply.

When one studies the historical record of the Hydro undertaking with a view to gaining therefrom guidance with respect to the future, the most oustanding fact that presents itself is the remarkable rapidity and continuity of growth in demand for power. The rate of growth has in fact been such that one of the most serious difficulties constantly confronting those responsible for the administration of the undertaking has been the failure, on the part of all but those most intimately concerned, to appreciate the magnitude of the provisions necessary to keep abreast of the demands.

Many of you will recall the early days of the Commission's activities, the time when Adam Beck—at that time he had not been knighted—was negotiating for the 100,000 horsepower with which he hoped to establish the work of the Commission upon a firm basis. At this time even so staunch a supporter and one so much interested in the welfare of the people of the Province as the then Premier, James Whitney, said that 10,000 horsepower would be all that would be necessary to meet the needs of the municipalities for years to come. There was no unwillingness on the part of Sir James Whitney to do all that was necessary for the people of his native Province, but his outlook and knowledge of the particular circumstances involved, were quite different from those of his friend and colleague, Sir Adam Beck. And so, I submit that just as Adam Beck's views proved to be more correct with regard to the electrical needs of the Province and what was required to meet them than were those of the



equally patriotic James Whitney; so, correspondingly, those who are now charged with the responsibility of appraising and providing for the future power needs of the citizens of Ontario, have made a provision that is much more in harmony with what the future will demand than are the appraisements of those who contend that provisions of the magnitude of those made should not be provided.

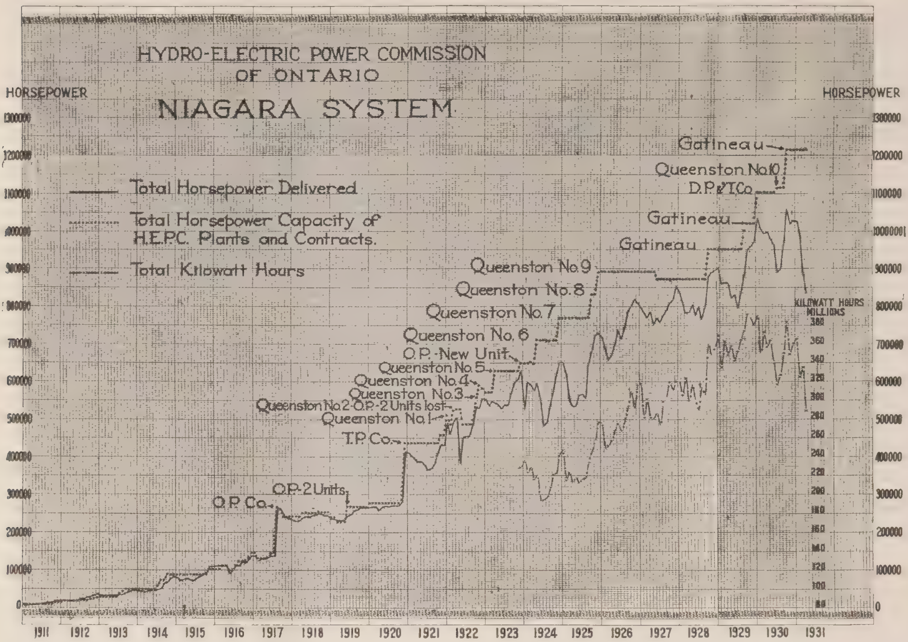
Again, the Queenston-Chippawa development, built primarily to care for what many then regarded as the abnormally expanded demands of war-time, but coming into actual operation only subsequent to the armistice and in the midst of a serious industrial depression, gave rise to forebodings and pessimistic predictions with regard to the absorption of the output. Nevertheless—and this is a fact of special importance—at a time when markets were by no means as extensive as they are at the present time, an additional supply of 550,000 horse power was absorbed in five years.

Still another illustration is afforded by the course of events in the Thunder Bay district. After a very thorough and painstaking survey of probable markets for power in this district, the Commission recommended the proceeding with the development of 75,000 horsepower at Cameron Falls on the Nipigon River. Again the Commission had to overcome many obstacles before it was permitted to proceed. The amount of power provided was high in relation to the population of the district, but the Commission, knowing the character of the natural resources in the area, was confident that at least this quantity was required to meet probable power demands. Here also a temporary condition, in this case overproduction in the pulp and paper industry, caused a slowing up of the immediate demands for power, and the Nipigon development was characterized through the press and also from the public platform as a "colossal blunder", a "burden of expense", a "foolish investment", and the "great white elephant" of power development. In contrast with these predictions, the actual history of the system records that not only was nearly all of the 75,000 horsepower placed in use within the time predicted, but the Commission has since found it necessary to construct a further development of 54,000 horsepower at the adjacent Alexander power site.

And it may be added that a careful consideration of the history of the work of the Commission will show that throughout the twenty-five years of this history there has been a good practical balancing between demand and the provisions for supply which the Commission has furnished. Moreover, this balancing is observable even over relatively short periods of time in which there have occurred sharp temporary setbacks in rate of growth of demands which have caused some publicly to express misgiving.

PRESENT PROSPECTS FOR ABSORPTION OF POWER PROVIDED

Now, the present position is that the Commission's load in the Niagara system as of last December, is some 1,082,000 horsepower, and provision has been made up to a total supply of 1,650,000 horsepower at the power



developments generating power to take care of requirements in the next six years. It should not, however, hastily be assumed that the difference between these two quantities represents the net amount of power available, as losses of transmission and transformation have to be taken care of. Roughly speaking, it may be said that the Commission's program contemplates an increase of load in the next five or six years of some 450,000 to 500,000 horsepower, which was approximately the condition existing at the time of the commencement of operation of the Queenston-Chippawa plants in 1922.

In the earlier part of the Commission's experience, an annual increase of 30,000 to 40,000 horsepower was regarded as what might be expected. Such an increase then represented a substantial percentage growth in the total amount supplied. In recent years, however, increases of 80,000 to 120,000 horsepower per year have come to be the regular experience. That is to say, it has been the experience of the Commission that the increase of load over a period of years tends to be a constant percentage—about ten per cent.—and, therefore, an ever-increasing quantity. This experience of the Commission has been in a general way parallelled also by electrical utilities in other progressive territories. Thus, with respect to quantities contemplated in the Commission's program, the past history of the undertaking furnishes very definite encouragement for the future.

(To be continued.)

Control Accounts—their Function and Operation

By H. T. Macdonald, Municipal Auditor, H.E.P.C. of Ont.

(Introduction to discussion by Accounting and Office Administration section of Association of Municipal Electrical Utilities at Ottawa, June 25, 1931.)

FOR a number of years, there were practically no control accounts in the municipality, and it has now come to a point where it forms part of our standard accounting system, and all municipalities at sometime will have to install control accounts. There are many features to be gained by installing control accounts. You take a man in business: as a rule, he records his sales. He is interested in the sales as the vital point of his business, and then the collecting of the accounts is another point to be considered; but the main thing is the sales, and I think, in our business, that is the way we should look at it. It should be the sales, and, in order to keep track of our sales, we must have a system of accumulating the data and checking up our charges and taking into revenue our sales and not the revenue that is collected. Sales are revenue. The other is receipts. There are several methods of doing this. You can do it by hand, by an ordinary adding machine, or by the more advanced method, mechanical billing. However, we are not billing machine salesmen, and we don't want that to enter into it. The point is we are discussing control.

Some municipalities balance monthly, and some use our cycle system of balancing, which we think is the better system.

Now the advantage in control—and we will discuss the cycle system where you bill the customer, you accumulate the data, the statistical information, which is very, very valuable, and you take into revenue the charges and then the bills go out. You allow the customers ten days to pay their bills. At the end of ten days, the discount period, there are some accounts still outstanding, so we decided that from three to five days would be a good time to balance; five days after discount date. That allows a number of accounts to come in after discount date. Five days after discount date, then, our standard practice is to follow up the arrears so, by balancing your district, you extend all the accounts outstanding, gross, and you send out a notice to your customers that they are in arrears. Now you kill two birds with the one stone by balancing your ledger and also making up your arrears sheet, and we find that the collections are made wonderfully by that method. The old method was that a balance was not taken. The accounts were gone over occasionally and at no particular time except the 31st of December was a list of arrears actually taken off. That is in dollars and cents—the actual amount outstanding. But in this method of balancing controls, every cent has to be accounted for or the balance will not be right and, therefore, a list is made up to follow up the account. The improvement in collections alone

is worth the trouble of installing controls, and you will find, as a rule, it is not the customers or the conditions that are at fault, but the personnel of the office staff, whether you have guarantees or otherwise. As a rule, it comes back to the office staff. If they are good collectors, they are getting the money. If they carry out the rules and regulations, they will get the money. You can talk about guaranteed deposits and all that sort of thing, but that is not the reason for bad accounts. It is the personnel of the staff. Where you have control accounts, you follow up these accounts periodically at a given date, each billing period, and it has a great effect. Now the staff wants to have as few arrears as possible, and that means they are going to pay more attention to their collections, and it has a wonderful bearing on collections. Apart from that, there is another feature. Without listing your charges, you don't know whether your revenue is being collected or not. If you just take into revenue the receipts and you don't know what your charges are, how can you account for the difference? You can't do it unless you have a record. Now that is something to take into consideration—accounting for the charges. If you bill $1,000.00 and you get so much money, you should have so much to collect—the balance. Before we went into controls as much as we have, there were a few places in the Province that tried a system of listing charges and taking the amount in net, and then they kept in the cash-book the forfeited discount and revenue collected, but they never balanced. At the end of the year, they tried to strike a balance but they were so far out that they gave it up as a hopeless job. If you do not record all the data and information, you will never have a control system that is satisfactory; but where you take the pains to record everything as it is being done, you will have no trouble in balancing. Now many people find difficulty in balancing. They get mixed up in the forfeited discount. That seems to be the stumbling block. Now we have control forms that run from "1" to "5", and sheet number "4" is the discount sheet. If the clerk posting the cash on the last discount date would take that sheet and any amount that has been collected, gross, she will put the discount on that sheet. Now, when it comes to balancing, that clerk will get the discount sheet and she will extend all the unpaid bills, gross, and list the balance of the discount at that time. That takes care of the discount problem with very little difficulty if she gets down to it. Now the other trouble in connection with balancing is that it is some times not done systematically. If you take all your information, your previous arrears list, plus your other charges, less your credits and your discount sheet and tick every individual item off as you are going through the cards once, and try your balance when you get finished, there are just two things wrong. Your cash has been incorrectly posted or your charges are wrong. As a rule, it is in the cash, but if you go through them, take your time and go through them, you can immediately see a card where there is something wrong. If there is something on there, an additional billing, it will be on sheet No. 2, and

you will take it off, a regular billing that appears at the regular billing date, and that is a good custom. When you come to where there has been a charge added or any arrears, you have to take time to check it. The point is that some times time is not taken to systematically check the control to arrive at a balance.

Uniform Accounting—General

By R. P. Darrell, Municipal Auditor, H.E.P.C. of Ont.

(Introduction to discussion by Accounting and Office Administration section of Association of Municipal Electrical Utilities at Ottawa, June 25, 1931.)

SINCE the aim of every Commission is to secure the fixing of economical and equitable rates, it is necessary that the accounts furnishing the basis on which rates are made be accurate.

A great deal of time and care is given to the preparation of the annual reports by the H.E.P.C. in order that authentic vital information may be readily available to all interested parties—particularly to those whose business is Hydro.

From a Municipal Commission's point of view, the principal advantages accruing from these Annual Reports lie in their comparative facilities which enable them to check their local operating costs against those of municipalities of like size in population or volume of business.

This emphasizes that a proper basis for comparisons is necessary if full consideration and fair deductions and decisions are to be given these matters by Utility Commissions. Proper comparisons cannot be made between municipalities with regard to cost and efficiency or operating ratios unless they are each keeping their accounts in precisely the same manner.

If the accounts differ materially comparative values are negatived.

Sometimes it is apparent that municipalities are influenced to a greater or less degree by their financial position.

Take two Utilities of like size or volume of business. One is in very healthy financial condition—almost embarrassed with liquid assets—and there are a number of these; the other is just keeping out of the red. What do we find the tendencies in these two offices?—

In the first one—new capital, or replacements, or rebuilding labour is charged to operating expense; anything to keep down the annual profits.

In the other Utility as much labour as possible and sometimes tree-trimming is charged to Depreciation Account. If this went unchallenged and were allowed to stand, where would be the comparative values of the annual reports.

Then we find other Utilities will correctly segregate all legitimate operating expense from Capital or Reserve charges, but their classification is wrong.

A glance at the report will show

that a number of them have no expense in connection with Billing and Collecting. Presumably the community's public spiritedness is of the highest order—these consumers read their own meters, compute their bills and voluntarily pay their dollars into these offices, or banks as the case may be. There are others that have never had any transformer or meter maintenance costs—splendid tributes to the manufacturers, if true.

Now about your capital accounts:

We have held suspicions amounting almost to conviction that the books of many Hydro Utilities reflect inflated Capital values. This has come about from a usage prevalent in so many of them—i.e., charging all new material purchased direct to capital.

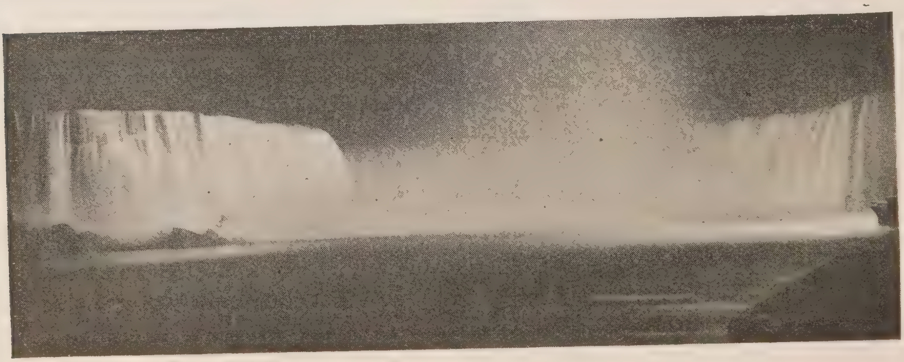
I have a particular case in mind where poles, cross arms, insulators, weatherproof wire, etc., were purchased probably because the prices were right and the time opportune for stocking up to take care of future expansion — this material was all charged to K.

Some time after—a disastrous fire resulted in a large part of this equipment being used to replace that destroyed, and only through chance and our inquisitiveness about the conflagration we recalled having read of in the newspapers did we learn this and were able to adjust the accounts in conformity with this information.

Personally I have always held the conviction that only equipment actually put into use (transformers and meters excepted) should be charged to Plant and that all equipment held in reserve should be carried in a stores account and accounted for by the adoption of a work order system. Of course, this would not apply to smaller systems whose annual purchases are comparatively quite small.

Mention of the classification of capital and operating accounts has been omitted as unnecessary.

These are set forth in such explicit detail in the "Uniform System of Accounting" for Hydro Municipalities as to require no elaboration, so I have endeavoured to confine the subject to cases of incorrect accounting and the ignoring of uniformity which we so often find in a number of offices.



Contact Phenomena

By F. H. Farmer, Manager of Engineering, Westinghouse Electric and Manufacturing Company, Chicago, Ill.

(*Read before Association of Municipal Electrical Utilities at Ottawa, June 25, 1931.*)

THE ideal electrical circuit is one in which there is continuity of low resistance metal, and contacts or joints should be kept to a minimum.

Any joint or contact in a circuit should have very low resistance, and this becomes of especial importance as the current increases. The heat energy generated by a joint equals I^2R, and as the current increases the heating increases as the square. This heat is generated locally and the temperature of the material in the immediate vicinity will increase until the radiation and convection is equal to the generation of heat. Obviously a decrease in the resistance is a necessary factor in keeping the contact cool. The factors which may influence the resistance are the area of contact, pressure and condition of surfaces.

The limiting temperature of a joint is that at which it can operate continuously without commencing oxidation which will increase the reresistance, and therefore tend to increase the heat generated, thus resulting in a cumulative action. For this reason a temperature rise of 30 degrees above an ambient temperature of 40 degrees has been adopted as a maximum for the temperature rise of switch contacts. The oxidation of copper increases rather rapidly above 70 degrees cent., and experiment has shown that at a temperature of 90 degrees a clean contact in the air increased its resistance 60 times in two hours.

An ideal condition would be obtained with contact surfaces perfectly smooth and flat, but such a condition is not practically attainable. A commercially flat surface is obtained by draw-filing or using a disc wheel with emery cloth which is the substitute for this ideal surface, and thus in reality presents a large number of points of contact scattered over the whole surface. Each one of these does its part in providing a path for the current, and results in a satisfactory conductivity under only moderate pressure. In considering the behavior of conductors in contact, this idea should be kept in mind and a clearer understanding will result of some of the problems which we have to meet.

If a contact is of a permanent nature which is not required to be opened in course of operation, it is possible to clamp or bolt it in such a way as to take full advantage of contact pressure. A contact which has to be opened such as that of a knife switch or a circuit breaker contact must depend upon spring pressure in some form.

The following laws may be taken to govern the behavior of a contact carrying current.

1. Contact or joint behaves as a simple resistance. The voltage drop is directly proportional to the current flowing.

2. Where the condition of surfaces in the contact are not affected adversely, the voltage drop across a contact will vary inversely with the pressure. Another way of stating the same fact is that the resistance between contacts depends not upon their area, but only on the total pressure with which they are forced together.

3. The resistance between materials in contact depends upon the internal resistance of the materials themselves.

While these facts have been established by experiment for many years, this disregard of area of contact seems at first opposed to general experience.

A distinction must be made between contact resistance and contact temperature. The amount of heat generated $= I^2R$, the product of the resistance and the square of the current. The ability of the contact to dispose of this heat depends upon the amount of radiation which it offers, which is a function of the area exposed to the cooling medium whether air or oil. Another important factor is the oxidizing effect of air on metals (usually copper) which forms the contact. Ability to continue in operation without deterioration is essential to successful operation of any current carrying contact. The condition of the contact surface, that is, whether of clean metal or whether covered by a high resistance coating of dirt or oxidization, has a very important bearing upon the contact resistance.

Copper is the metal principally used on current carrying contacts on account of high conductivity. It has one outstanding characteristic, however, which is troublesome; namely, its ready oxidization when exposed to air. Even at room temperature slow oxidization will take place, and under high temperatures oxidization is extremely rapid. Another respect in which copper is not most desirable is the fact that it has no well defined elastic limit, and is therefore not an ideal material to use as a spring. This can be overcome to some extent by using hard drawn copper.

The behavior of copper when exposed to oxidizing influence is rather peculiar. When exposed freely to air a film of copper oxide ($Cu\ O$) is formed. This oxide of copper has a high resistivity and consequently impairs contact considerably.

If a contact which has thus been oxidized is further subjected to temperature with a deficiency of air or oxygen, there appears to be a tendency for the copper oxide to be converted into a different oxide, namely Cu_2O which has a much lower resistance, and this probably accounts for a phenomenon which has been observed that contacts after heating considerably due to oxidization in operation will drop down to nearly normal temperature. On cooling off again in air the original oxide is restored and as often as the operation is repeated there is some increase in contact resistance as the film becomes thicker.

The prevention of formation of such a film is therefore of great importance, and various means are employed to achieve this end.

If contact surfaces are absolutely flat, the entry of air is prevented, and this precludes oxidization from taking place. Practically this is an impossible condition to attain, and the nearest approach which we can get is that of a draw-filed and polished surface. This gives a large number of points of contact, and the entry of air is so much restricted that oxidization is extremely slow. Further-more, in the case of a knife switch with a sliding action between the surfaces, each time the switch is operated a large number of these points of contact are cleaned up so that any tendency towards oxidization is removed. For these reasons it is necessary that the surfaces in contact should present as large a percentage as possible of actual touching in order to get best results from a temperature standpoint.

It will be noted from the foregoing that it is not the actual area which results in the lower temperature, but it is the indirect result of the flat surfaces aiding in keeping the oxidizing agent away from the copper and also aiding in the periodic cleaning of points in contact through operation.

The simplest form of joint is one in which the two conductors are solidly bolted together. In this case there is no possibility of a wiping action to remove oxide. It therefore is essential to have well fitted surfaces, and to have a high pressure of contact, with sufficient bolt to bring all parts of the surface into intimate contact.

Frequently the surfaces after being prepared are tinned before bolting up. This has merit in that the soldered surface is not so readily oxidized as the bare copper, and furthermore owing to its softness there is a more intimate contact set up. The probability is that the initial resistance of such a joint is somewhat higher than a clean copper to copper joint, but the sustained resistance is probably lower over a long period of service.

An expedient which is frequently used with good results is to spread a thin layer of vaseline over the clean surface before bolting up. The introduction of such material seems on first consideration to be opposed to good practise as vaseline in itself is non-conducting. Actually, however, the actual contact points readily pierce the vaseline, and that which remains effectively seals against entry of oxygen from the air, or any corrosive fumes which may be present. This treatment has been used with excellent results on the copper joints in wiring around frame of large d.c. generators, where variations in resistance of series and parallel paths may adversely affect commutation.

Aluminum is the only real competitor of copper as a current carrying conductor, and while it can compete with copper in many respects from an economy standpoint, it is under a real disadvantage in that it cannot be readily soldered, and it has a high rate of oxidization.

We might note the value of silver as a contact material. Silver has a very high conductivity somewhat greater than copper, and is highly resistant to oxidization and is therefore an ideal material from a contact

standpoint. It, however, is expensive, and cannot be justified for ordinary contact purposes.

It may be pointed out that silver-plated contacts have been used recently with excellent results on the contacts of circuit breakers carrying heavy currents where the heat generated is difficult to control, and there are indications that this practise will become more general.

Terminal lugs are essentially intended to be capable of disconnection and are dependent upon the bolting together of surfaces. Obviously the important thing is that they should be securely bolted together, and except on small terminals two or more bolts are much to be preferred over one large bolt. With two bolts a lateral displacement is impossible, whereas with one bolt this may take place inadvertently thus loosening up the bolt slightly even though some form of lock washer has been used. Too much emphases cannot be laid upon the care necessary in properly tightening up terminal lugs since these are usually insulated after making and the external evidence of heat is not readily detected.

Apparatus designed to open and close electric circuits covers a wide range, and we can only discuss such equipment in so far as the operation of the contact making parts is concerned.

Certain forms of equipment are intended to open a circuit in which no current is flowing, or at least only a low current, and no design features are introduced which are capable of interrupting large currents successfully. In such equipment represented by knife switches and disconnecting switches, the thermal consideration is the essential one. Such switches almost invariably operate in air, and must be capable of carrying the maximum current continuously without heating and without any undue amount of maintenance. It is essential that such switches should not open accidentally through vibration or gravity when in service since this would result in the drawing of a power arc.

We have seen that high pressure of contact is the ideal, and this is not readily obtained with any of the hinged switches which are most generally used. There is no difficulty in obtaining good pressure at the hinge since this is a bolted contact, but the jaw contact depends upon the spring effect of the two jaw elements pressing against the blade, which obviously cannot exert any great pressure unless they are made relatively large. Actually the area of contact of such switches is relatively large, and the unit pressure low. This permits of sufficient radiating surface to dissipate the heat.

The contact surfaces must make good contact all over in order to prevent voids which will encourage oxidization, and to distribute the current uniformly over the surface.

On a knife switch no provision is made for the effective opening of a circuit where there is any considerable amperage. On breaking contact an arc is struck which means that a metallic vapor presents a conducting path through which the current flows. The heat thus generated is very considerable and results in the fusion of a certain amount of metal, and the longer the arc persists the more metal is burnt away. If this burning

takes place upon a surface which is normally a contact surface, the contact is seriously impaired.

Where the current breaking duty is light the arc is drawn from the leaving edge of the blade and only very slight pitting action takes place upon the contact surface, and this is not severe if scoured naturally when the switch is reclosed.

Knife switches are normally rated 30 degrees cent. rise, and should be selected to have capacity equivalent to the combined one hour overload rating of apparatus served. They are designed on a basis of not over 1,000 amperes per square inch of sectional area. It may be noted that in the larger sizes the d.c. capacity is greater than the a.c. capacity due to the skin effect in the case of a.c. which tends to crowd the current to the vicinity of the surface of the conductor. Similarly the 25 cycle capacity is somewhat greater than the 60 cycle capacity.

As an example the knife switch, which has a capacity of 2,800 amperes, 60 cycle—is rated 3,400 amperes at 25 cycle and 4,000 amperes d.c. So far we have considered only the ability of a contact to continuously carry its current without developing injurious heating. This is the primary essential in any contact, but in the case of those contacts which have to function to interrupt a flow of power there is a problem of the greatest importance.

In the development of the electrical art it became apparent at an early stage that an ordinary switch was inadequate to handle the arc which resulted from opening a power circuit and especially so as voltages increased, and the size of circuits developed. Time will not permit to touch more than very briefly upon this development.

In successfully breaking an arc it is necessary that the operation be performed very rapidly, since the amount of heat generated is a function of the time that the arc persists. The behavior of the arc has been the subject of a great amount of study by electrical manufacturers and independent research engineers, and it is of interest to know that within the past two or three years developments have taken place which mark a great advance in the design of circuit breakers.

An arc will persist until a certain length is reached depending upon the voltage which is being interrupted, so that high speed of separation is one of the first essentials. On all circuit breakers operating in air, the moving contact is carried on an arm which is closed upon the stationary contacts against a strong spring, and then latched in so that the pressure is equal to that exerted by the spring. In this way we fulfill the condition of high pressure.

When it becomes necessary to open the circuit the latch is tripped, and the spring forces the contacts apart at a high rate of separation. Since these breakers are used only on relatively low voltage, principally direct current, the arc cannot persist over any considerable distance and is consequently broken with no undue heating of the breaker contacts.

It is general practise to equip the current carrying contact with auxiliary contacts made of hard carbon, which are so arranged that they make

contact earlier, and break contact later than the main contacts. Thus as the main contacts open the current is all diverted into the carbon contacts, which then carry the arc, and the main contact surface is unimpaired. This separation is horizontal and the natural tendency of the arc to rise assists in lengthening the path.

Such breakers have their general application on direct current circuits, 250 volts, general purposes, and railway 600 volts, and also 1,500 volts railway service with larger separation.

The type of main contact which has been found most satisfactory for this type of breaker is a semi-elliptical brush contact of hard drawn copper laminations with a phosphor bronze backing piece. The faces are milled so that the extremities project a little further than the inner portion. This results in each individual lamination exerting pressure without any crowding from its neighboring lamination, and we have in effect a series of line contacts.

Formerly these breakers were built under two ratings—20 degrees cent., and 30 degrees cent., although A.I.E.E. Standards only call for 30 degrees cent., with clean bright contacts. Present guarantees specify ability to carry full rated load with a 40 degree ambient, without any injurious heating at any part.

There is a limitation to the pressure which may be exerted by a brush contact since copper is not by any means an ideal material in its mechanical properties. Hard drawn copper if overstressed will be permanently strained, and consequently will lose some of its spring. A contact which is forced with too great a pressure will suffer, and care must be exercised in making adjustment that this point is not exceeded.

High Speed Air Circuit Breaker

This breaker presents a contrast to the carbon breaker in that it utilizes a butt contact instead of a brush contact. The high speed breaker which is of fairly recent origin is designed primarily for the protection of d.c. machines against short circuits which are liable to cause flashover between opposite polarities on the commutator, and afford a valuable protection to railway generators, especially on automatic applications. The inherent characteristics of this breaker is to discriminate between short circuits which cause an instantaneous rise in current and a legitimate load which may rise relatively gradually to a high value.

The breaker is of the contactor type of construction and arranged for pedestal mounting. The contacts are of the butt type, and on the 3,000 ampere breaker a single stationary member is engaged by a movable contact. The conventional arcing contacts are omitted in order to obtain more rapid opening after the tripping impulse is received, and the inertia of the moving part is kept to a minimum. An arc chute placed immediately over the contact, and provided with a powerful magnetic blowout, serves to rapidly lengthen the arc to a point where the circuit will be interrupted.

Since there is a time element in the operation of a latch mechanism, the latch is omitted, and the breaker is

closed in electrically by a solenoid against spring tension and then sealed by a holding magnet. An electrical weakening of the holding magnet permits the spring to open contacts immediately, and the short circuit can be interrupted in a few thousandths of a second.

The use of butt contacts under heavy pressure has been found to give entirely satisfactory operation without any excessive maintenance, and it will be realized that if more cumbersome form of contact were used, the rapidity of operation which is essential would be defeated.

Deion Breaker

The development of the Deion Breaker and its production in a commercial form in 1929 has been perhaps the most outstanding event in circuit breaker history of recent years. In the air breakers so far considered the rupture of the arc has been effected by rapid separation and the use of a magnetic blowout to rapidly increase the length of the arc.

In the Deion breaker, which is applicable for the rupture of medium voltage a.c. arcs in air, a different principle is involved. The arc resulting from opening the circuit is transferred from the main contacts to a shunted circuit consisting of a multiplicity of short arcs in series which are then independently moved by a magnetic field over closely spaced metal plates so that a cold cathode arc is produced which can be interrupted within one-half cycle to two-half cycles.

A considerable number of these breakers rated at 15,000 volts are now in successful operation, and a series of tests made on the Commonwealth Edison system currents as high as 22,400 amperes per phase at 12,000 volts have been successfully interrupted. In this breaker as now developed, there are two stationary contacts which are bridged by a conventional movable brush contact. The arc is transferred from suitable arcing tips by a magnetic blow in field into the deionizing chamber which consists of a stack of thin metal plates spaced a short distance apart. The single arc as it is drawn in is subdivided, sufficient gaps being provided to give a working stress of about 110 volts per gap. The individual chambers are subject to a radial field which is set up with field coils in the deionizing chamber. The action of the arc on this radial field causes it to travel with great rapidity around the chamber at a speed of several thousand feet per second, and the arc is cooled and extinguished with no burning of the plates which form the series gaps.

It is not within the scope of this paper to more than thus briefly outline this important development. The value of a breaker which can rupture very great capacities without the hazard of oil is obvious, and the principle of the subdivided arc has been incorporated in equipment other than that intended for the rupturing of high power circuits.

Passing from the Deion Breaker capable of rupturing one-half to three-quarter of a million kv-a., we find this new principle of arc breaking incorporated in a snap switch small enough to be mounted in a panelboard for domestic and building control.

The conventional form of snap switch embodies the high speed break feature operated by means of a toggle mechanism with a spring. It has sliding self-cleaning contacts depending upon the spring effect of the jaws for pressure, and is backed by a fuse to protect against short circuit, or other overload beyond the capacity of the wiring. This is a switch which has fulfilled requirements for many years, and the replacement of fuses after disturbance has been accepted as a matter of course.

A new type of snap switch which has recently been perfected is in reality a miniature circuit breaker, since it embodies a thermal overload trip device and the Deion principle of arc rupture. This remarkable device, which is known by the trade name of the "Flip-on" switch, is of such dimensions that it can be mounted in a panelboard or in what is termed a "no-Fuze" load centre.

The defects of the common form of fuse protection are very apparent to operating men. Replacement of fuses is a troublesome operation. Fuses may be replaced by higher capacity than intended by unauthorized persons. They can easily be shorted out completely thus destroying the protection they are intended to supply, and they frequently cause interruption due to momentary overloads which do not actually endanger the winding.

In the "Flip-on" switch the toggle mechanism actuates the contacts which are subject to full contact pressure up to the instant of release and which are of a non-welding material. A latch holds the mechanism in the closed position until it is released manually or automatically, and this latch is subject to the action of a bi-metallic thermal element which is capable of very close calibration.

High rupturing capacity is secured through the application of the Deion principle. The moving contact passes through a series of slots in metallic plates which subdivide the arc, and present a large cooling surface for the individual arcs.

The thermal element gives desirable overload characteristics. The device will carry 110 per cent. load continuously, or will trip within one minute at 150 per cent load. For greater overloads the time of trip will be correspondingly less. To reset the thermal device the handle is merely returned to the off position. The efficacy of the Deion feature may be gauged from the fact that these small devices can rupture a short circuit of 5,000 amperes at 125 volts d.c. in .009 seconds.

"Flip-on" devices are made in capacities from 15 to 50 amperes and provide a most effective form of protective switching device, for branch circuits and domestic appliances.

CONTACTORS

Industrial control presents problems in contact making essentially different from those we have so far considered. In the control of motors we frequently find it necessary to make contacts with great rapidity, and this may run into thousands of operations daily. The contact making device must be rugged, and as simple as possible, and as a rule must

be electrically operated from the supply circuit. High cost cannot be justified.

In the contactor as used on d.c. and a.c. motor control, we have a shaft carrying one or more contact arms which close contacts against spring pressure through rotation of the shaft through a small angle.

The electro-magnet which operates the shaft has its stationary core mounted solidly on the panel, and the movable portion of the core is swivelled on an arm attached to the shaft. The air gap is such that the solenoid which is mounted on a stationary leg of the core is capable of starting the contacts to close under the lowest voltage which may be encountered. As the armature closes upon the stationary core the magnetic flux increases due to the decreased reluctance, and when the magnetic contact is closed it exerts a powerful torque on the shaft capable of holding in all the contact arms against their springs. As the operating coil is de-energized the spring pressure against the contacts immediately opens them up.

The moving contact has a rocking action so that as it first makes the contact is made on the toe of the contact, and as it closes in the contact rolls until in the permanent contact position contact is made between flat portions of the fixed and moving contact.

The importance of contact pressure is well-exemplified in the behavior of contactors. In most cases where severe burning and unsatisfactory contact life is experienced the cause is found to be insufficient contact pressure. At the same time excessive pressure is dangerous since the coil will be unable to fully close the magnetic circuit, and a burn out of the a.c. coil is likely to occur. Information is furnished as to the limits within which the spring pressure should be adjusted.

It is expected that contacts will burn away due to severity of service, and they are arranged for ease of replacement. In order to overcome difficulty due to residual magnetism holding the armature in and not responding to the opening of the control circuit, the main core is supplied with a small air gap which introduces enough reluctance to kill the residual.

It is necessary to make a distinction between contactors used intermittently, and those used in application where there is a prolonged run for perhaps a number of hours. The long time service requires a more liberal capacity partly because of the combined thermal condition, and also because of the lack of scouring effect which results from the make and break of contacts.

Oil Circuit Breakers

Until the advent of the Deion breaker circuit interrupting devices operating in air were applicable only to low voltages, and the progress of electrical generation and transmission has been accompanied of necessity by the development of circuit breaking devices capable of handling the most severe duty which could be imposed under fault conditions.

The oil circuit breaker has held its place for many years as the device best suited for closing and opening an a.c. circuit under service conditions.

In this type of breaker the contact is submerged under oil, and the arc which is caused by opening contacts is subject to the cooling effect of a body of oil, and is able to persist for only a short distance.

In so far as contact making characteristics are concerned, the oil immersed contact operates under favorable conditions. The important factors are pressure freedom from any film of poorly conducting material, and ability to rapidly conduct away such heat as is developed.

The oil breaker permits the use of contacts capable of sustaining high pressure, and due to the fact that it is immersed in oil which has no corrosive or oxidizing action on copper, a surface is maintained which is free from any high resistance film, and which, unless it is subjected to burning and pitting from the arc, will maintain a low resistance contact for an indefinite period. On account of the intimate contact between the oil and the metal parts of the contact, any heat generated is readily carried away by convection and dissipated by radiation from the tank.

The ultimate capacity of a circuit breaker is expressed as the amperes that it is capable of interrupting at a certain stated voltage without suffering damage, either mechanically through the explosive effect of the arc, or by the destruction of the contacts. It will be necessary to confine ourselves to the contacts themselves and the methods used for relieving them of destructive arcing effect.

When an alternating current arc is drawn under oil the heat of the arc volatizes the oil in the immediate vicinity of the arc and forms a bubble of volatized oil with a small content of volatized metal. This arc space has a conducting characteristic, but as the current passes through its zero point a recovery of dielectric strength takes place, and if the recovery voltage is rapid enough to restrike an arc, the arc persists for the next cycle. The factors which tend to prevent the recurrence of the arc are the deionization of the volatized space which is naturally cooled by the wall of cool oil as the bubble rises, and also the separation of contacts at each successive zero point of current. From this it follows that the factors which tend to keep the arc to a minimum are the ability of the oil to rapidly cool the arc, and a high speed of separation of the contacts. The total distance of separation must be such that under no conditions can an arc persist when the breaker has come to its full open position.

The disruptive effect of an arc in a breaker is largely a function of the period during which the arc persists, since the amount of gas generated, and the amount of burning of contacts both depend upon the duration of the arc. The carbonization of oil is also similarly influenced.

While it is necessary to make an examination of oil and contacts as soon as possible after the rupture of a severe short, a breaker should be capable of maintaining its condition over long periods with ordinary inspection.

On the usual form of oil breaker the essential features are rapid and positive separation, and ample oil capacity to permit of the free escape of the bubble of gas which is formed.

Since a burning of contacts has to take place during the process of rupturing the arc an auxiliary contact or tip is connected to the current carrying contact, and so arranged that the arc struck at the time of opening will affect the tip and not the main contact. Contacts as used in oil breakers have taken various forms, depending upon the currents to be normally carried and the severity of arcs to be ruptured.

On the smaller capacity breakers the moving element has "V" shaped contacts, whose sides are inclined at an angle of about 30 degrees. As these are raised they engage fingers arranged in pairs facing each other and supported by stiff steel springs in such a way that they are free to rock in either direction. In this way we are assured of a uniform contact pressure over the entire surface. The 30 degree angle permits the proper amount of depression of the springs as the moving contact is drawn up, and at the same time the lateral pressure tends to force the contact out when the latch is released. An outer contact somewhat steeper having about a 20 degree angle rises somewhat higher than the main contacts, and so serves to act as an arcing tip.

As the larger current carrying capacities are reached this type of contact becomes impractical on account of the space which would be occupied, and in capacities of 1,200 amperes or more, and in some cases in lower capacities than this, a laminated hard drawn copper brush is employed. This is used both in the elliptical form similar to air breakers and in the inverted form.

Two parallel conductors having currents in the same direction are attracted towards each other, and consequently if we have two brush contacts in parallel on a single contact block, if they are so arranged that they toe outward, they will tend to approach each other when subjected to heavy current, and so exert additional contact pressure at the time when it is most needed. If on the other hand they toe inwards the reverse would be the case. This condition actually applies also on an elliptical contact which tends to open out under heavy current.

The inverted type of contact has been used very successfully on the larger capacity breakers.

In the continuous effort to improve circuit breaker operation, much consideration has been given to means of speeding up the rupture of the arc.

The obvious line of attack is to increase the speed of opening by means of throw-out springs or other mechanical means. A further development of this idea is the use of high speed arcing contacts, which remain latched in until the main contact has performed a considerable part of its travel, and attained full velocity, at which time the H.S. contacts snap out, and perform the first part of the arc breaking operation very rapidly. It is probable that we have reached the limitation of what can be done by purely mechanical means since as speeds increase mechanical shock increases, and this necessitates stronger and heavier parts thus increasing the inertia of moving parts.

A second method of accomplishing this result is to assist the deionization of the volatized oil by forcing oil into

the arc stream by mechanical means, and by the use of barriers to divert oil into the affected area. These means have merit, but have their limitations.

Following this development of the Deion Breaker, Dr. Slepian turned his attention to the suppression of arcs in oil, and has developed what is known as the Deion grid, which is a device capable of being built into an oil breaker which controls the arc in such a way as to quench it in a small fraction of the time attained by ordinary means.

In the Deion grid breaker, instead of moving cold oil into the arc stream, the arc stream, which has no inertia, is moved magnetically into a chamber where conditions are suitable for rapid deionization with the result that the arc decays in an incredibly short time.

In the Deion grid breaker, the current carrying contact is of the plain break-butt contact type, depending upon high contact pressure, and well adapted for passing rapidly through the oil without offering much resistance to movement. The stationary contacts are equipped with the conventional bells or static shields used in high voltage service.

The moving contact travels in a slot in a bank of fibre grid plates extending from above the stationary contact downwards about two-thirds of the travel. Imbedded in these fibre grid plates at intervals are iron plate elements in the form of a horse shoe, which envelopes the slot.

In each of the units there are three circular enlargements of the slot which form pockets for the oil.

As the arc is made it passes between the leads of the iron plates in such a relation that it induces a flux which crosses the air gap, thus forming a field at right angles to the flow of current, tending to force the arc inward towards the rear of the magnet. In moving inward the arc encounters cool oil in the oil chamber which rapidly deionizes it. If any arc remains it will be forced into the second chamber, and further deionized. The same operation will continue in each successive grid unit until the arc is dissipated.

The results obtained with this new form of arc extinction are such as to warrant its being regarded as the most important development in oil breakers of recent years.

In a series of field tests made on a 66 kv. system, with a 7,000 ampere short circuit capacity, the average of 35 openings was 1.8 cycles on a 60 cycle basis. The separation speed was 7.5 feet per second indicating that the arc was suppressed on the average in one-quarter of the stroke. A noteworthy feature is the fact that the oil which tested an average of 22 kv. at the start was only reduced to an average of 18.6 at the end of test, although no change of oil was made. This in itself is a striking evidence of the relatively small thermal effect due to the extreme rapidity of interruption of the arc.

The employment of a simple butt contact, devoid of high speed contacts or other devices, together with this novel method of controlling the arc has produced a circuit interrupting device which represents the highest development of the art.

Association of Municipal Electrical Utilities

Report of Committee on Research

THE Committee has held one meeting since the last summer's Convention, and begs to submit the following report:

The Committee strongly recommends that the Association support the Resolution passed at its Winter Convention in 1930 and forwarded to the Hydro-Electric Power Commission. The Commission and the Association of Municipal Electrical Utilities should be at all times in the forefront and fully advised on developments in electrical research and in its applications to the transmission, distribution and utilization of electricity. This is necessary in order to permit the Commission to take advantage of new developments.

An increasing amount of attention is being given each year to research by public utilities everywhere. It is being realized that this is necessary on the part of utilities as much as on the part of the manufacturers and that the success of the utilities in selling electricity depends upon research to a considerable extent.

The main branches of research in which the Commission is engaged, and which, in the opinion of the Committee, should be extended are as follows:

1. Generation, Transmission, and Distribution.—Methods of operation, improvement in apparatus, destructive phenomena on transmission lines and in apparatus, and methods of combating the same.

2. Utilization.—Improvements in utilization, equipment, new markets for electrical energy, development of off-peak load, etc.

The following subjects are suggested as being of pressing importance at the present time, and the attention of the Association and the Commission is directed to them:

1. Load Balancing.—Following the discussion of Mr. Lawler's paper at Bigwin Inn Convention in 1930, in the matter of the development of a 220-volt element for electric ranges, the matter was referred to the Research Committee, and shortly after this a manufacturer constructed a range with a 220-volt element. This range has not been put on the market and no results appear as yet to have followed the discussion which was raised at Bigwin Convention. Your Committee begs to stress the need for research looking towards the development of 220-volt range element having long life. This is partly a manufacturer's problem, but the Commission can be of assistance, and it is strongly urged to bring this question before the manufacturer.

2. Water Heating.—A considerable amount of research has been carried on within recent years in the United States and Europe, to which reference is made in Mr. Barnes' paper presented at this Convention. The Committee strongly recommends that the Commission undertake an active investigation of this subject from all

points of view, and suggests that attention might be directed to development of a low-voltage element in conjunction with a tank of large capacity for operation during off-peak periods, believing that this offers the possibility of permitting a large number of heating installations without changing present load characteristics.

3. *Remote Control of Consumers' Loads.*—A reliable and cheap method of controlling consumers' loads from sub-stations would be of great value in permitting the installation of water heaters, house heaters, etc., which otherwise would affect the peak. Some work has been done by the Commission's laboratory on this subject, and the Committee recommends that this be encouraged and continued.

4. *Electrolytic Production of Oxygen and Hydrogen.*—The electrolytic production of oxygen and hydrogen offers a field for the utilization of off-peak power. This tremendously important subject has received world-wide attention and many large installations are now in existence in connection with various industries, such as the gas industry, electro-chemical industries and others. The Committee suggests this as a fertile field for investigation, looking towards the utilization of off-peak energy.

5. *Heating of Houses.*—The heating of houses by the method of extracting heat from outside air (reverse Carnot cycle) has received attention principally in Europe. This is a matter of such great importance to this country that its study should be furthered. It is furthermore in the province of the Commission, since it could be made a source of profit from the sale of energy. The same principle may be used for the cooling of houses in summer. This would be particularly attractive from the point of view of the Commission, since it would increase the summer load.

6. *Methods of Installation.*—The Committee recommends strongly that a study be made of present methods of electrical installation, with the view to reducing cost or to obtaining installations of larger capacity at the same cost, in order to encourage the installation of more adequate wiring. The excellent results of the operation of the Commission's Rules and Regulations is fully appreciated and such research should be co-ordinated with the activities of the Commission's Inspection Department in order that requirements of safety may be met.

7. *Electric Cooking.*—The production of cooking equipment of lower cost, lower energy demand and greater efficiency, would, in the opinion of the Committee, greatly increase the sale of cooking utensils, which would re-act to the advantage of the manufacturer, retailer, householder and Commission.

8. *Grounding.*—The Commission has appointed a Committee for the purpose of investigating the subject of grounding. This Committee has been in operation for several years, and is doing a large amount of work in the compilation of information, testing of ground resistances and development of methods of grounding, especially in rural localities. The Committee recommends that the

A.M.E.U. support this work and be prepared to co-operate with the Commission in its investigations. It believes that considerable research work should be done in determining soil resistance conditions in Ontario, methods of maintaining low ground resistances.

9. 25 Cycle Motors on 208 Volt Networks.—Characteristics of 220 volt 60 cycle motors operating at 208 volts have been worked out, but similar information has not been obtained for 25 cycle motors. The Committee recommends that the Commission should undertake this work in view of its important application to the problems of the 208 volt networks which are extending rapidly in the province at the present time.

10. The Committee directs attention to the *lighting service* of the Commission's laboratory, which is a free service rendered to all municipalities and to the customers of the Commission. This service has been extending since its inception, but is capable of much greater extension. The Committee recommends this service to all municipalities.

11. Electro-culture.— Considerable attention has been directed to this subject, especially in recent years in Europe, and very satisfactory results have been reported at various times. These investigations have followed several paths, the heating of the soil, the use of corona discharge, and the application of intense light of varying spectral value.

The above are a few of the most important points to which the Committee begs to direct your attention. This list is by no means complete, but contains problems the solution of which is important to the Hydro enterprise at the present time, and it is hoped that this report will receive the earnest attention of the Association and of the Commission, and may result in further progress along the lines recommended.

Minutes of Convention

The twenty-ninth Convention of the Association of Municipal Electrical Utilities was opened at the Chateau Laurier, Ottawa, at 10.00 o'clock on the morning of Thursday, June 25th, 1931, by the President, Mr. J. W. Peart.

The first item on the programme was a paper "Electric Heating for Domestic Service" by A. S. L. Barnes, General Laboratory Engineer, Hydro-Electric Power Commission of Ontario. Discussion following Mr. Barnes paper was by Messrs. W. B. Buchanan, E. V. Buchanan, O. M. Perry, H. F. Shearer and M. P. Whelen.

Mr. F. H. Farmer, Manager of Engineering, Westinghouse Electric and Manufacturing Company, Chicago, Ill., read a paper entitled "Contact Phenomena", which was illustrated by lantern slides.

The President then extended to Mr. Barnes and to Mr. Farmer the appreciation of the delegates for the papers they had read, after which the session adjourned.

At 12.30 p.m. the delegates met with the Ontario Municipal Electric Association for the first Convention luncheon. His Worship, Mayor J. J. Allen, gave a short address welcoming the delegates of both Associations to

Ottawa. In reply Mr. C. A. Maguire, President, O.M.E.A. expressed the appreciation of the delegates for the hearty welcome extended to them.

Alderman J. Edward McVeigh, Chairman, Industrial and Publicity Commission, Ottawa, then spoke outlining the proposed sight-seeing trip planned for that afternoon.

Mr. W. D'Arcy Ryan, Director, Illuminating Engineering Laboratory, General Electric Company, Schenectady, N.Y., gave an illustrated address entitled "History of Illumination with Special Reference to Spectacular Lighting." Mr. Ryan was introduced by Mr. M. J. McHenry of the Canadian General Electric Company.

At 3.00 o'clock that afternoon the delegates were the guests of the Industrial and Publicity Commission of Ottawa during a sight-seeing tour of the City, visiting the more important places of interest.

The second session of the Convention opened at 9.30 o'clock on the morning of Friday, June 26th, the President, Mr. J. W. Peart, in the chair.

Mr. E. V. Buchanan read a report from the Committee on Research and moved its adoption. On being seconded by Mr. C. E. Schwenger, Mr. Buchanan's motion was carried.

The Secretary then read a letter and resolution from the Kitchener Commission suggesting that there be but one Convention each year. As this same resolution was under consideration by the Ontario Municipal Electric Association at that time no action was taken on it.

He also presented the names of Messrs. R. J. Findlater and H. J. Franklin for election as Associates, and Kelvinator of Canada, Limited, as Commercial member. It was moved by Mr. G. E. Chase and seconded by Mr. R. J. Smith THAT the names presented by the Secretary be declared elected.—*Carried.*

Mr. H. E. Speare, Executive Manager, Central Station Retail Shop (Magazine), New York, N.Y., read a paper "Merchandising by Public Utilities."

Mr. F. A. Gaby, Chief Engineer, Hydro-Electric Power Commission of Ontario, gave an illustrated address entitled "Some Interesting Aspects of the Hydro System."

Mr. E. V. Buchanan moved a vote of thanks to Mr. Speare and to Mr. Gaby for their contributions towards the programme of that morning which was seconded and CARRIED.

Mr. J. E. B. Phelps moved a resolution expressing the thanks of the Association for the entertainment provided the delegates by the Industrial and Publicity Commission of Ottawa, The Gatineau Power Company, and the Ottawa Valley Power Company and The Hydro-Electric Power Commission of Ontario through the Chats Falls Executive Board, which was seconded and CARRIED.

Concurrently with the main Convention Sessions referred to above meetings were held on Accounting and Office Administration.

The first session of the Accounting and Office Administration section was opened at 10.00 o'clock on the morning of Thursday, June 25th, with Mr. R. L. Dobbin, Past President in the chair.

Mr. D. J. McAuley read the minutes of a meeting of the Committee

on Accounting and Office Administration held during March which were confirmed.

Mr. D. B. McColl, Manager, Hydro-Electric System, Walkerville, read a paper entitled "Consumers' Billing and Control Accounts".

Discussion following Mr. McColl's paper was by Messrs. W. E. Wallace, G. Appleton, W. H. Childs, G. E. Robertson, R. P. Darrell, R. M. Bond, H. L. Summerlee, S. Buckrell, B. Thackeray, I. N. Pritchard, and D. J. McAuley.

The next subject of discussion was "Control Accounts—their Function and Operation". Those taking part were Messrs. H. T. Macdonald, J. S. MacKenzie, R. M. Bond, G. Appleton, W. E. Wallace, I. N. Pritchard, D. B. McColl, F. O. Pelz, O. H. Scott, W. G. Hanna and B. Faichney.

"Uniform Accounting—General" was the next subject discussed, those speaking being Messrs. R. P. Darrell, G. Appleton, R. M. Bond, W. E. Schwartz, I. N. Pritchard, J. S. MacKenzie, E. W. Berquist, D. J. McAuley and D. B. McColl.

The Session then adjourned.

The Second Session of the Accounting and Office Administration section opened at 9.30 a.m. on Friday, June 26th.

The first subject discussed was "Uniform Accounting—Hydro Shop" in which the following took part: Messrs. W. B. Munroe, W. E. Wallace, R. M. Bond, R. P. Darrell, D. B. McColl, A. B. Scott, E. W. Berquist and A. B. Manson.

It was moved by Mr. W. E. Wallace and seconded by Mr. A. B. Manson, THAT the A.M.E.U. Executive Committee be asked to communicate with the H.E.P.C. requesting that the Operating surpluses and deficits in respect to Hydro shops be accumulated on the books of the Hydro Shops from inception, and that these figures be taken into consideration in computing the annual interest charge against the Shops, starting with the year 1931.—*Carried.*

Next item was "General Practices re the use of Depreciation Reserve".

Those discussing this subject were Messrs. D. J. McAuley, G. Appleton, R. M. Bond, D. B. McColl, A. D. Nelson, A. B. Scott, W. E. Wallace, W. G. Hanna, R. P. Darrell, and H. T. Macdonald.

The section then adjourned to join with the main Convention Session of that morning.

At 12.30 p.m., the delegates met with the Ontario Municipal Electric Association for the second convention luncheon, when Honourable J. R. Cooke, Chairman, and Right Honourable Arthur Meighen, Commissioner, Hydro-Electric Power Commission of Ontario, gave short addresses.

On this afternoon at 3.00 o'clock, the delegates were the guests of the Gatineau Power Company on a trip to the power plants on the Gatineau River.

At 7.00 o'clock the delegates met with the Ontario Electric Association for the Convention dinner when Mr. C. A. Maguire, President, O.M.E.A., was toastmaster, and Honourable Geo. S. Henry, Premier of Ontario, guest speaker.

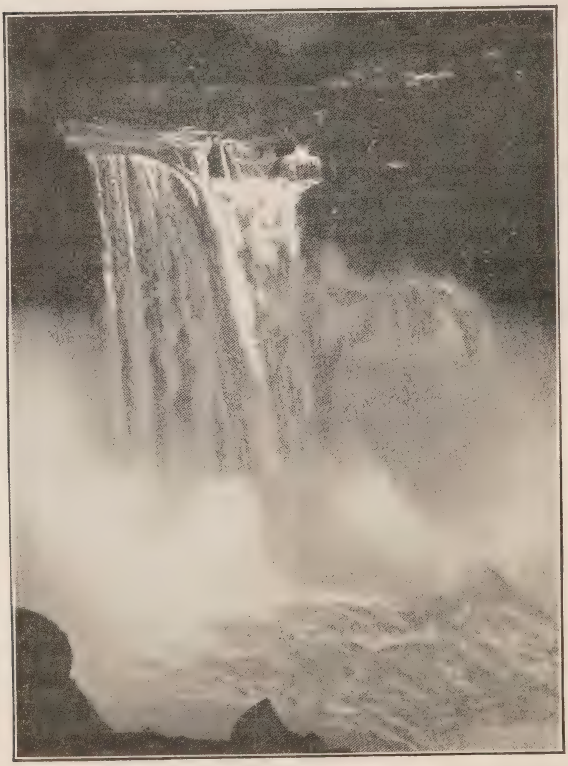
On Saturday, June 26th, the delegates were the guests of the Ottawa Valley Power Company and the Hydro-Electric Power Commission of Ontario through the Chats Falls

Executive Board on a trip of inspection to the Chats Falls Power Development.

The Convention register shows the total number of delegates present to have been 445, classified as follows:

Class "A"........	100
Class "B"........	172
Commercial......	88
Associates........	51
Visitors..........	34

There were 458 present at the Convention luncheon on June 25th and 428 on June 26th. The attendance at the Convention dinner on the evening of June 26th, was 508. The hotel reported the total party at the Convention, i.e.,—delegates, women and children to number about 650.



THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Adherence to Basic "Hydro" Principles and Growth of Power Demand

A Memorandum presented by the Hydro-Electric Power Commission of Ontario for Publication on September 1st, 1931.

THOSE responsible for the creation of Ontario's municipally-owned electrical undertaking laid down certain fundamental principles which were to find expression in the practical conduct of the work of the Commission and of the co-operating "Hydro" utilities.

For some time past there have appeared in the press statements to the effect that the Commission no longer adheres to certain basic principles which characterized its early operations and which are accepted as essential to the stability of the undertaking.

This Memorandum, which will be followed periodically by others, is merely a statement of facts to show that no departure from the basic principles of the Hydro organization has been made and also to indicate the substantial and satisfactory growth which has taken place during recent years, that is to say, during the very years in which claim has been made that the basic principles had been abandoned.

It has been stated that the Commission has departed from the principle of furnishing power to municipalities at the lowest possible cost, and in this connection it is pointed out that the purchasing of power from private corporations entails the payment of profit which might have inured to the public benefit had the Commission developed its own power.

No doubt to some unacquainted with circumstances under which the Commission has had to operate, such a statement may appear plausible. In the light of actual conditions, however, it may be seen to be entirely contrary to fact.

Basic Principle of Power "at Cost"

Perhaps the chief basic principle upon which the Commission operates

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is that ample supplies of electrical energy shall be available "at cost", and this cost, moreover, must be the lowest possible cost at which the power can be supplied consistent with sound economic procedure and through the employment of structures and equipment of such high standard as will ensure continuity of service. From the inception of the undertaking the Commission has realized that in any comprehensive system for the supply of electrical energy to a large territory, the ownership of the transmission lines and franchise rights for distribution is the dominating requirement and it was understood from the start that the Commission would procure its power by whatever means seemed best.

Purchased Power Used From the First

Purchased power was always regarded as an important and sometimes an inevitable source of supply. The Niagara System was started with 100,000 horsepower purchased from a private company in 1910, indeed from a foreign company, with incorporation in the United States. The Ottawa System, the Severn System, the Thunder Bay System, and the St. Lawrence System, were all started with purchased power and in other systems purchased power has been continously employed to supplement that generated by the Commission. It was not until the "Hydro" undertaking had become well and successfully established, namely in 1914, that the Commission constructed its first small power plant at Wasdells Falls in the Georgian Bay System.

In the early period of the Commission's operations, its contractual relationship to the municipalities of the Niagara district provided only for the use of purchased power, and the proposal of the Commission to develop its own power had to be specially submitted to the ratepayers of the Niagara district for their approval. In 1917, legislation cleared the way for the Commission to develop power at Niagara on behalf of the municipalities.

The Commission Acquires Its Own Plants

There followed a period when the Commission was able to make large power developments in Ontario waters and to acquire by purchase certain developments made by private companies. With the acquisition of these private developments and the completion of the Queenston-Chippawa plant, the power actually developed by the Commission exceeded that purchased. This practice of developing

power sites has, whenever possible, been continued by the Commission but in the case of the Niagara system the Commission during recent years has been confronted with circumstances which absolutely prevented it from proceeding with its own power developments.

Factors Retarding Development in International and Interprovincial Waters

The Commission's general policy with respect to power supplies will not be discussed here, because this subject is comprehensively dealt with in the formal statement of the Commission which appeared in the daily press of May 6th last. It is appropriate, however, here to say that the large hydro-electric demands of the Commission's Niagara system can only satisfactorily be met in Ontario from three main potential sources. These are: The international portion of the St. Lawrence in which Ontario has a half interest of the 2,000,000 horsepower potentiality; further development on the Niagara River when permission can be obtained for the use of additional water; and the interprovincial Ottawa River where there is an aggregate potentiality of about 1,000,000 horsepower, of which one-half belongs to Ontario. Problems relating to the St. Lawrence are still unsolved and even when solved it will probably be from seven to eight years before Ontario's full share of power would become available, and therefore the international reach of this river cannot be counted upon as an early source from which to meet power demands. With respect to Niagara power, the rejection by the United States Senate of the proposed amendment to the Boundary Waters Treaty took away hope for immediate development here. On the Ottawa River there are still large power sites which cannot be developed until certain matters involving rights and the co-ordination of various interests are adjusted. In view of such circumstances there was no satisfactory course open to the Commission to ensure power for the municipalities in the large quantities required except to purchase from developments outside of the Province.

The Commission Has Expert Advisors

The technical staff of the Commission—especially trained and experienced in such matters—has the problem of demand and supply of electrical energy constantly under its consideration. In a statement published by the heads of the engineering departments in January last, the considerations which determine the policy of those responsible for the provision of electrical service were outlined. Briefly stated, they include, *first*, an appreciation of the extensive and rich natural resources of the Province, which cannot be developed apart from the utilization of low-cost electrical power; *second*, the recognition that water power has in the past constituted and still is the best source of Ontario's supply; *third*, that large supplies of hydro-electrical energy cannot be made available on short notice, future power requirements must be evaluated and anticipated; *fourth*, some surplus power is of great benefit to encourage the establishment of new industries and to guard against unforeseen contingencies; *fifth*, growth in demand for electrical

energy is influenced by a number of factors, many of which are largely independent of the cyclical phenomena of prosperity and depression.

General Experience Respecting Electrical Growth

As to the probable demand for electrical energy which accompanies growth in economic activities, the engineers pointed out that there is available an experience extending over 25 to 30 years, which period includes various years of pronounced business depression. Among other statistics cited it was pointed out that, since 1918, there had never been a year recorded in which an output of electrical energy 50 per cent. greater than the then existing output has not been required within five years or less.

The Commission's Queenston-Chippawa plant was placed in operation in 1922. Its capacity of 550,000 horsepower was required by 1927.

During the period from 1922 to 1930—a period within which it is alleged there has been a departure from basic principles—it is well worth noting the fact that the December peak load in 1922 was 618,867 horsepower, and that in December, 1930, it was 1,286,278 horsepower, or an increase in these eight years of one hundred per cent.

Additional Power Supplies

Faced with a knowledge of the facts and with the considered opinion of its engineers, the following provisions for power from various sources and the supplying of it at stated intervals have been made.

In taking account of the facts set forth in the following paragraph it must be remembered that deliveries of the purchased power are in the main deferred, being spread over a period of six years, and the Commission pays only as the power is delivered.

The contracts entered into by the Commission since 1926 for purchased power are as follows: 260,000 horsepower from the Gatineau Power Company; a further contract covering an additional 60,000 horsepower also from the Gatineau; 250,000 horsepower from the Beauharnois development being made in Quebec on the St. Lawrence River; 125,000 horsepower from the MacLaren development on the Lievre River, also in Quebec; 96,000 horsepower from the Quebec portion of the Chats Falls development on the Ottawa River; and for the development of Northerly Ontario 100,000 horsepower to be produced at the Abitibi Canyon on the Abitibi River in Ontario. The Commission will also have 96,000 horsepower from its own portion of the development at Chats Falls. These provisions for power, together with the output of the Commission's existing generating plants, will aggregate in all about 2,000,000 horsepower by 1937.

Line Loss and Reserve Capacity

It is appropriate here to draw attention to the fact that while there is a gross provision of 2,000,000 horsepower, yet there would be a substantial reduction in this amount due to transmission losses and due also to the desirability of providing ample reserve capacity. Up to the present, the Commission has not been able to make available the plant capacity

usually set aside by operating organizations for reserve to ensure emergency requirements occasioned by break-down or other exceptional demands. Results of research published last month respecting the amount of spare capacity considered by many of the United States electrical systems as necessary to ensure continuous service, shows a provision of from 10 to 35 per cent. of spare capacity. The Commission in part has had to rely upon the exceptionally high quality of its physical structures and transmission line equipment, coupled with the exceptional facilities it has provided for the interconnection of various systems and the interchange of power.

The Commission has not up to now been able to provide even the minimum of reserve which operating organizations in general have considered it the part of wisdom to ensure.

Provision for the Next Six Years

The present position then with respect to power resources is that the Commission's load as of last December was nearly 1,300,000 horsepower. If this be increased by the minimum amount of but ten per cent. as a provision for reserve capacity, it becomes 1,430,000 horsepower, which represents the demand upon the Commission's available power supplies as of last December. This leaves a gross amount of about 570,000 horsepower available, or making reasonable allowances for transmission losses on purchased power, etc., this becomes a net amount of about 500,000 horsepower available to meet the needs of the next six years. In the light of past experience this provision for contemplated increase is reasonable and is only such as constitutes a proper insurance for growth in normal demand and a wise provision for future industrial advance.

The purchases already referred to were made in order to provide power for the municipalities according to the accompanying schedule.

Growth of Hydro From 1922 to 1930

In order to show how great has been the progress of the Commission in other respects during this period

POWER DELIVERIES FOR SOUTHERN ONTARIO
FROM
GATINEAU, CHATS FALLS*, BEAUHARNOIS AND MacLAREN

Available for Peaks in Fiscal Year	Purchased Power H.P.	Commission's Plants H.P.	Total Amount H.P.
1931–32	64,000	48,000	112,000
1932–33	89,000	48,000	137,000
1933–34	66,000	.....	66,000
1934–35	80,000	.....	80,000
1935–36	100,000	.....	100,000
1936–37	118,000	.....	118,000
	TOTAL (not making provision for losses)		613,000

* Chats Falls supply may be curtailed due to water regulation.

from 1922 to 1930, it may be pointed out that the municipalities served rose from 348 in 1922 to 685 in 1930; the number of consumers from 364,988 to 586,276. The Commission's reserves rose from $9,387,422 in 1922 to $54,944,849 in 1930; the municipal reserves from $18,387,011 to $48,912,833; the transmission lines, including rural, rose from 3,578 miles in 1922, to 13,157 miles in 1930; the capital invested by the Commission in 1922 was $172,033,231 and in 1930 it was $260,593,779; the capital invested by the municipalities in the construction or purchase of their own local distributing systems rose from $53,583,399 in 1922 to $99,054,262 in 1930. Thus, the aggregate capital investment in the undertaking of about $256,000,000 in 1922 increased in 1930 to about $360,000,000. Such figures speak for themselves.

The Commission has never claimed infallibility, but it does claim that it, its staff, and the local utilities and their staffs, have all functioned with singleness of purpose and with the best technical skill and experience at command, in the interest of the whole Hydro undertaking.

The contention that there has been a departure from basic principles, or that proper judgment is not being exercised in the provision of power supplies cannot be supported by proper evidence, and certainly seldom emanates from any who have devoted themselves either to the creation of the Hydro undertaking or to constructive effort in furthering its growth.

Substandard Electric Water Heaters

THE Commission has been administering the regulations governing the sale of electric equipment for many years and in carrying on this work has encountered at times cases of deliberate and unscrupulous attempts to circumvent these efforts. Several particularly glaring examples of such attempts have occurred this year. The methods used are so objectionable and the devices so dangerous that we desire to give the fullest publicity to these tactics in order that the public may be fully warned. This is especially necessary since the methods of selling, which will be described below, render it very difficult for the Inspection Department to find the offenders. Several unapproved and substandard types of electric water heaters containing particularly dangerous features have been offered for sale throughout Ontario during the past summer. These heaters are all made in the United States and are sold by mail order to individuals or to agents who are encouraged to peddle them from house to house throughout the country. Evidently, the proposals to the agents are very attractive since over one dozen different types of these heaters have been detected during the past six months. In many cases the agents are non-technical and do not understand that they are breaking the law in offering these devices for sale; in other cases they are fully conversant with the regulations and

Hot Water— Instantly

FOR EVERY PURPOSE
At The Snap of a Switch

[redacted]

ELECTRIC HOT WATER HEATER Gives You Sizzling Hot Water In Few Minutes

Made of pure heavy aluminum, with high grade heating element. 8 feet heavy duty insulated rubber cord. Operates on A. C. or D. C. 110 volt current.

You can now have Hot Water in any part of your home—ALMOST INSTANTLY. Made possible by this New Invention, "[redacted] Electric Heater." And, so simple—just place Heater in water—attach cord to any light socket—and quicker than you can ever imagine, you have boiling Hot Water—for your dishes—washing clothes—Cleaning—window washing—shaving or for what ever it may be needed.

And, best of all, this Hot Water is brought to you in much less time than required by Gas, Coal or any other method of heating water. No more waiting for the Gas Heater—oil stove, or Coal Range—the [redacted] Heater is ALWAYS ready for instant service.

Works on new principle—the old way required heating of the utensil FIRST, before water became warm—With this new, modern method the heater gets right into the water and HEATS IT UP QUICK AS A FLASH.

WASHING DISHES MADE EASY

Have Hot Water
Whenever You Want It
From Your Light Socket

SO HANDY FOR SHAVING

Enjoy shaving with all the Hot Water you need WITHOUT WAITING—no time wasted running down to the basement to light the heater. And it's just as convenient as your electric light—just place heater in the water,—give the switch a snap—and PRESTO—there's your hot water. Could anything be more simple?

The "[redacted] Heater" is no larger than the palm of your hand and fits neatly into your traveling bag—take it along wherever you go—and always have Hot Water when you need it

Water for the Baby's bath made ready quickly and without any inconvenience or time wasted—and it's the correct temperature, too.

Likewise the Hot Water Bag so often needed in a hurry can be made ready for instant use—because the [redacted] Heater will have the water hot without a moment's delay.

[redacted] Heater not only heats the water but STERILIZES DRINKING WATER by positively killing the germs that the water may contain, and makes it safe for drinking at all times.

WONDERFUL FOR BABY'S BATH

HANDY FOR THE GARAGE

Think of the convenience of having hot water right in the garage for washing or starting the car—and it's there whenever you need it—without waiting. Place heater in water—attach to light socket and PRESTO—you've got Hot Water—All you want without wasting a minutes time.

COMES TO YOU READY FOR INSTANT USE—no extra parts to buy. No adjustments to make—nothing to get out of order. Easily taken apart for cleaning.

Our representative will gladly demonstrate the "[redacted] Heater" to you. Get in touch with him NOW. Or write us and we'll have him call on you.

OUR GUARANTEE

We guarantee the [redacted] Electric Heater against defective material and workmanship, when used according to instructions. It is substantially constructed and will give years of service.

[redacted] PRODUCTS CO. CHICAGO, ILLINOIS

DISTRIBUTED BY

Reproduction of an advertisement of a dangerous appliance

employ trickery to deceive the public and the inspection department.

In all of these heaters the electric element is in contact with the water and usually consists of a coil of bare heating element mounted on a piece of asbestos wood, and enclosed by a perforated sheet metal case. This type is supplied with a length of rubber-insulated cord and it is designed to be immersed in the water which it is desired to heat. Another type is designed for attachment to a faucet, but it is essentially the same in construction and contains the same hazards. If the user should touch the water or the metal pan in which the heater is immersed, he would be subject to danger from shock. Tests have been made in the laboratory indicating that voltages from 50 to 110 exist between the water near the heater and the neighbouring grounded objects such as a faucet: under proper conditions this voltage is sufficient to cause death.

The following are the names of some of these heaters:

"Tom Thumb, Senior"
"Tom Thumb, Junior"
"Aladdin"
"Hot Shot"
"Major"—These are all of the faucet type.

The following are the names of some of the immersion type:

"Lux-Visel" or "Magic Disc"
"Mystosol"
"Aladdin"
"Wonder"
"Jiffy"
"Best-Ever"
"Kwik"
"Comer"

The following is an illustration of the methods employed by some of these manufacturers: The laboratory notified a certain manufacturer in June that the device could not be sold in Ontario. A letter was received from this manufacturer protesting against our action and stating that over 200,000 of this device had been in use in the States and had caused no trouble. This is a common method used by manufacturers of this character to deceive the public. How they should have the effrontery to endeavour to deceive the Inspection Department by such a statement is remarkable. Some further correspondence passed between the laboratory and this manufacturer. Following this correspondence a perspective agent came to the laboratory who showed us a letter which stated that "they were almost positive the laboratory would prove their heater to be satisfactory and permit it to be sold in Ontario." This agent was saved considerable trouble by enquiring as to the reliability of the claims made to him. Others unfortunately have not and have been subjected to the inconvenience of prosecution for violation of the regulations. The Commission is endeavouring to administer its regulations in the interests of the public as well as those reputable manufacturers who supply safe products. It is hoped, therefore, that no encouragement will be given to firms following the tactics described above.

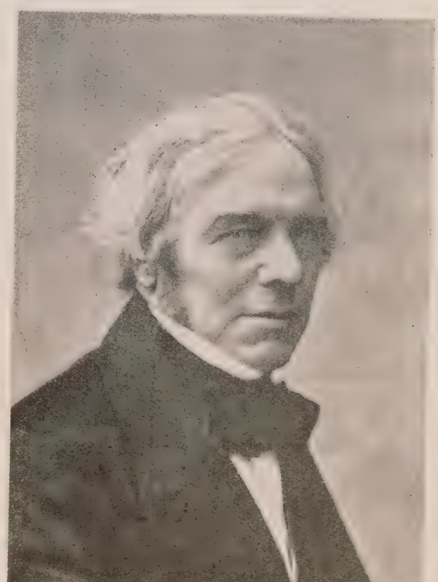
Michael Faraday

IT was on August 29, 1831—one hundred years ago—that Michael Faraday made observations as the result of his experimental research in electro-magnetic induction, which are the foundation of all modern systems generating and distributing electricity, as also many of its applications.

A celebration commemorating this event was held in London, England from September 19th to 25th. *The Electrical Review* of August 28th, in giving notice of that celebration, publishes an illustrated article by Professor E. W. Marchant, giving a brief outline of Michael Faraday's life and work, from which the following is excerpted:

Mr. R. Appleyard, in his "Tribute to Michael Faraday," has endeavoured to trace some of his ancestors, and has discovered some particulars which throw light on the reason for his parents leaving Yorkshire and settling in London. It seems evident that the original house, Clapham Wood Hall, near Clapham in Yorkshire, in which his grandfather, John Faraday, lived, was converted by him into a cotton mill. Later it was called the "Bobbin Mill," which appears to show that the owners changed their trade from weaving to bobbin winding. There was a severe depression in the cotton industry at the end of the eighteneth century and the family migrated to London. Michael Faraday was the third son of James Faraday, a blacksmith, who married in 1786 Margaret Hastwell, a farmer's daughter of Mallestang, near Kirby Stephen in Westmorland. Soon after their marriage his parents made their home at Newington, near what was once the village of Walworth, where their son Michael was born on September 22nd, 1791. The registers recording his birthplace were preserved, but recent inquiry has failed to identify the house where he was born.

The family suffered considerable privations owing to the general distress prevailing during the French wars. In 1796 his father took his wife to Gilbert Street, where he obtained rooms over a coachhouse in Jacobs Well Mews, Manchester Square. Michael was then five years old and "found his playground in the streets in the neighbourhood of Spanish Place." Nothing is known of his early education, except that it consisted of little more than the



Michael Faraday
1791-1867

rudiments of reading, writing, and arithmetic.

After leaving school he entered the employment of a Mr. Riebau, a bookseller at 2 Blandford Street, London, where he did his duties as errand-boy so promptly and so well that his master apprenticed him, without premium, to the trade of bookbinder.

Chemical and Electrical Studies

In 1809 the Faraday family removed to Weymouth Street, and on October 30th, 1810, Michael's father died. By that time he was beginning to read books as well as bind them, and thus he was introduced to the rudiments of chemistry and electricity.

In 1812 a Mr. Dance, one of the customers of the bookshop, found Michael Faraday studying an article on electricity in a book that he was binding, and gave him four tickets for some lectures by Sir Humphry Davy at the Royal Institution. Faraday took notes at those lectures and a little later when there was a vacancy at the Royal Institution for a laboratory assistant he sent them to Sir Humphry Davy, who was so impressed by them that he gave Michael Faraday the post at a salary of 25s. a week with two rooms, in which to live, at the top of the house. Although Faraday was intensely studious, he was neither dull nor ascetic. Mr. Appleyard quotes a letter that he wrote to a friend at that time. . . . "There is a grand party and dinner at the Jacques Hotel, which immediately faces the back of the Institution, and the music is so excellent that I cannot for the life of me help running, at every new piece they play, to the window to hear them."

At that stage in his career an opportunity arose which enabled him to "graduate in the University of the World," for Sir Humphry Davy in 1813, accompanied by Lady Davy, started out on a Continental tour.

On his return, one of his first tasks was to put in order the mineralogical collection at the Royal Institution. He was also occupied in extracting sugar from beetroot and in making an explosive chloride of nitrogen. When he was not busy with the Royal Institution laboratories, he was manufacturing rare chemicals, or performing analyses. He "squeezed chlorine into a liquid" and applied it successfully as a disinfectant when fever broke out in the Millbank penitentiary. At that time he was educating himself in "English composition, style, delivery, reading, oratory, grammar, pronunciation, and perspicuity," for he experienced great difficulty in presenting his ideas in proper sequence . . . "I always find myself obliged, if any argument is of the least importance, to draw up a plan of it on paper and fill in the parts by recalling them to mind, and this done I have a series of major and minor heads in order, and from these I work out my matter." It is, of course, common knowledge that, later, at the Royal Institution, he proved a master of the art of exposition and drew audiences to his lectures such as had seldom been seen in England.

Early Lectures

One of his earliest lectures was at the City Philosophical Society on the "General Properties of Matter." Later he gave six further lectures and

in 1817 his famous lecture on combustion. His standing in the scientific world was rising rapidly; the experience he had gained in lecturing and the severe schooling he had undergone in elocution brought their own reward, for in 1820 he was an accomplished speaker. He was married in June, 1821, and set up home at the Royal Institution, though in 1823, still acting as Davy's chemical assistant, he had the misfortune to injure his eyes as the result of an explosion. He was elected a Fellow of the Royal Society in 1824 and in 1825 was appointed director of the laboratory under the Professor of Chemistry (Sir Humphry Davy), and in 1826 started the Friday evening discourses, which have since become famous, in the theatre of the Royal Institution. He was fond of entertaining friends at the Royal Institution, and after dinner they played like boys; sometimes he ran round the theatre of the institution on a velocipede, which was then a new thing. Among artists Faraday appears to have been well acquainted with Turner, who consulted him about pigments. He never failed to see all the sights of the day and led a full and active life.

It is not possible in a short article to deal with the work which Faraday did in electro-chemistry and his study of the laws of electrolysis, or with his classical researches on dielectrics. It was Faraday who first explained the meaning of specific inductive capacity, and his theory of the polarisation of dielectrics is to-day generally accepted. His work on benzine and his chemical researches would fill another volume, but the experiments he made in 1831 with the hope of obtaining electricity from "ordinary magnetism" are the ones that we wish especially to recall to-day.

The experiments which led to the discovery of electro-magnetic induction are described in his "Experimental Researches"; they began with an investigation of the induction of electric currents. "Two coils of copper wire were wound on a cylinder of wood and prevented from touching each other by strong calico and twine." One was connected with a galvanometer, and the other "with a voltaic battery of 10 plates 4 in. square with double coppers and well charged," yet not the slightest sensible deflection of the galvanometer needle could be observed. "Next 203 ft. of copper wire in one length was coiled round a large block of wood, and another 203 ft. of similar wire was interposed as a spiral between the turns of the first coil, and metallic contact was prevented by twine. One of these helices was connected with a galvanometer and the other with a battery "of 100 pairs of plates 4 in. square with double coppers and well charged." Then he notes ". . . when the contact was made there was a sudden and very slight effect at the galvanometer, and there was also a slight effect when the contact with the battery was broken."

Induction Experiments

By that time he had begun to suspect that the action between the two coils was really due to the magnetism produced by the current flowing round one of them, so in his next experiments he used a welded ring of soft round bar iron, 7/8 in. thickness and 6 in. in external

diameter. Three helices were wound round one part of the ring, each containing about 24 ft. of copper wire 1/20 in. thick. "They were insulated from the iron and each other in the manner already explained. On the other part of the ring about 60 ft. of similar copper wire in two pieces was applied in the same manner, forming a helix B. The helix B was connected by copper wires with a galvanometer 3 ft. from the ring. The helices A were connected end to end, so as to form one common helix, the extremities of which were connected with a battery of 10 pairs of plates 4 in. square." On August 29th, 1831, he noted that the galvanometer was immediately affected and "to a degree far beyond what has been described when, with a battery of tenfold power, helices, without iron, were used." Upon using the power of 100 pairs of plates with this ring "the impulse at the galvanometer when contact was broken was so great as to make the needle spin round rapidly four or five times before its motion was reduced to mere oscillations. By using charcoal at the ends of the B helix a minute spark could be seen when the contact of the battery with A was completed. The spark was rarely seen on breaking contact. A small platinum wire could not be ignited by this current, but there seems every reason to believe that the effect would be obtained by using a stronger original current, or a more powerful arrangement of helices."

Another arrangement was then employed "connecting the former experiments on volta electric induction with the present," and this I think is the most important discovery that Faraday made.

The experiments with the iron ring had shown that the induction effect in one of the helices was probably due to magnetism, but it was only in the experiments described below that he showed that an electric current could be produced by a magnet. "The combination of helices was constructed upon a hollow cylinder of pasteboard. There were eight lengths of copper wire containing altogether 220 ft. Four of these helices were connected end to end, and then with the galvanometer; the other intervening four were also connected end to end, and a battery of 100 pairs of plates discharged through them. In this form the effect on the galvanometer was hardly sensible, though magnets could be made by the induced current. When a soft-iron cylinder 7/8 in. thick and 12 in. long was introduced into the pasteboard tube, surrounded by the helices, then the induced current affected the galvanometer powerfully, and with all the phenomena just described." Then he goes on ". . . . similar effects were then produced by ordinary magnets; thus, the hollow helix just described had all its helices connected with the galvanometer by two copper wires each 5 ft. in length. A soft-iron cylinder was introduced into its axis. A couple of bar magnets, each 24 in. long, were arranged with their opposite poles at one end in contact, so as to resemble a horse-shoe magnet, and then contact was made between the other poles and the ends of the iron cylinder, so as to convert it for a time into a magnet. By breaking magnetic contacts, or reversing them, the magnetism

of the iron cylinder could be destroyed, or reversed, at pleasure. Upon making magnetic contact the needle was deflected . . . continuing the contact, the needle became indifferent and resumed its first position. On breaking contact again it was again affected, but in the opposite direction."

Later he proceeds ". . . as it might be supposed that it was by some peculiar effect taking place during the formation of the magnet, and not by its mere virtual approximation that the momentary induced current was excited."

Fundamental Experiment

The following experiment was made: ". . . all the similar ends of the compound hollow helix were bound together by copper wire, forming two general terminations, and these were connected with the galvanometer . . ." A cylindrical magnet ¾ in. in diameter, and 8½ in. in length was used. "One end of this magnet was introduced into the axis of the helix and then, the galvanometer needle being stationary, the magnet was suddenly thrust in. Immediately the needle was deflected in the same direction, as if the magnet had been formed by either of the two proceding processes. Being left in, the galvanometer needle resumed its first position and then, the magnet being withdrawn, the needle was deflected in the opposite direction. . . . By introducing and withdrawing the magnet so that the impulse each time should be added to those previously communicated to the needle, the latter could be made to vibrate through an arc of 180 degrees or more." That was the first alternator and the fundamental experiment, because it was then that Faraday first showed that an electric current could be produced by the motion of a magnet. In other words, by the interaction between a magnet and a coil of wire the mechanical energy used in moving the magnet could be transformed into the electrical energy developed by the coil.

This is the principle on which practically all the electrical energy used to-day is generated. Many engineers have been engaged in the development of dynamo machines and alternators, and many of them who made great advances deserve recognition, but, primarily, dynamos and alternators depend on Faraday's experiments, and without his discovery there would be no electric power supply to-day. Nowadays nearly all the experiments he described are carried out in every physics laboratory and there is no difficulty in repeating them, because we now have all the apparatus required to carry them out easily, but it needed the genius of Faraday to visualise what happened when a magnet was thrust into a coil. It was he who first suggested lines of force, who was the first to present a picture of what might be assumed to be happening in the space surrounding a magnet, a picture which has been of incalculable value to all who have had to deal with magnets ever since. What would the electrical engineer do without lines of force? How could we picture magneto-electric induction without them? Faraday "filled in" the space surrounding a magnet. It was the medium that was the active cause in

magnetic induction and, whether we believe in the ether or not, Faraday gave us something for which we can never adequately repay him.

When later in his life he became world-famous, he still showed the attitude of the true seeker after truth. In the preface to his "Experimental Researches" he says ". . . other parts of these researches have received the honour of critical attention from various philosophers, to all of whom I am obliged . . . and, although I cannot honestly say that I wish to be found in error, yet I do fervently hope that the progress of science in the hands of its many zealous cultivators will be such as will even . . . make me think that what is written and illustrated in these experimental researches belongs to the bye-gone paths of science."

Such was his modesty in his achievements. His fame is now established, and he will never be forgotten so long as science is studied by mankind. We have in him as good a model of the scientific investigator as we may ever hope to see; a skilful experimenter with a genius for observation, and for the interpretation of the results of his experiments; always seeking new truths, not greatly concerned with their practical applications, wholly oblivious of their financial value, but always anxious to probe further into the secrets of nature. Withal, a man of simple life, of simple yet courtly manners, of simple faith, a man as great in his simplicity as any man of science who has ever lived.

Oak Tree on the road between St. George and Paris, Ont.

Trees

By Joyce Kilmer.

I think that I shall never see
A poem lovely as a tree,

A tree whose hungry mouth is prest
Against the earth's sweet flowing
breast;

A tree that looks to God all day
And lifts her leafy arms to pray;

A tree that may in summer wear
A nest of robins in her hair;

Upon whose bosom snow has lain;
Who intimately lives with rain.

Poems are made by fools like me,
But only God can make a tree.

Radio Interference

III

Locating and Suppressing Interference

THE sources of radio interference are many and varied. Several of the more common sources are classified in the June issue of the *Bulletin*. If the source can be located, it may be possible to remove the cause of the interference: until the source is found, however, there is very little hope of successfully eliminating the trouble.

It is in realization of this that a large number of men are employed by the Radio Branch of the Department of Marine, and sent out with specially equipped cars to locate sources of interference in the many cities and towns throughout the Dominion. These men are searching continually and ready on call to trace down any source of interference reported. Some methods of locating interference may easily be applied by any broadcast listener without special equipment whereas other methods employed in search for certain types of interference require very delicate measuring instruments used in conjunction with highly sensitive radio receivers.

Household Appliances

The source of interference may be in the same house as the radio receiver, being caused either by some device operating normally, or by a fault. If it be normal operation of an appliance, then a study of the interference caused by different appliances should readily suggest the source, and the turning on or off of suspected appliances may find the one giving trouble. If it be a fault, however, this may be found by disturbing the appliances while power is on.

If a battery operated receiver be available, a general test, to determine if the source be in the house lighting circuit or not, may be made by opening the main supply switch but this test would not be satisfactory with an a.c. receiver.

Where an appliance is found to be causing interference while in normal operation, some type of filter or surge trap should be used. This will consist of grouped fixed condensers, or inductance coils, or both, giving a circuit which confines the sudden variations in voltage or current within the device. By preventing such changes from occurring also on the supply circuits, it is possible to prevent radiations which would cause interference in radio receivers in the same house or elsewhere in the neighbourhood. Suitable surge traps have been designed and have proven satisfactory in preventing interference from many appliances.

Faults in household appliances may be of different types but usually only those which show spark discharges and cause overheating of contacts are responsible for radio interference. These may be readily found as the noise stops with the shutting off of

the device and the faulty part is usually quite warm.

Every user of appliances should take care to see that his equipment, including all plugs, sockets, switches, and extension cords, is kept in good order so as not to cause interference. Particularly should attention be given to this matter by non-users of radio receivers as they have no loud speaker to indicate that there is interference from their circuits.

Industrial Appliances

These sources of interference may be found by applying similar tests to those used for household appliances. The interference from any device, however, may be carried by lighting and power lines over a considerable area, in which case it often is necessary to trace down the interference by means of a car equipped with a radio receiver, noting whether the strength of the interference increases or decreases when moving in a given direction along the lines. The interference may even be transferred to other lines, which complication may make it very difficult to trace.

Filters and surge traps again are the most satisfactory method of suppressing interference at its source, when it occurs in normal operation of the device.

Where the cause is a fault, the device should be disturbed,—shaken or jarred,—*e.g.*, by tapping the pole which supports it, or by tapping the device itself while listening on a radio receiver. When found, the fault should be removed as soon as possible: this is particularly important with industrial appliances where faults may develop rapidly and may cause interruption to service.

Surge Traps

To trap an interfering surge, it is necessary to choke its travel out and along supply lines and then to absorb its energy.

In some instances where the surge is of a high radio frequency, the impedance of the lines to travel of the surge is so large as to be a sufficient choke, in which case it may be necessary only to add a group of fixed condensers to absorb the energy.

Where the surge frequency is lower and the impedance of the lines to travel consequently much less, inductance coils must be added, one in each supply line, to give sufficient choking effect. These coils consist of several turns of wire with an air core and so wound, in one or more layers, that the electrostatic capacity between the end turns is not large, *i.e.*, that the inductance of the coil be not nullified by its electrostatic capacity between leads.

It is important, in most cases, where choke coils and condensers are used together, that the condensers be connected across the supply lines between the choke coils and the device causing interference, otherwise the condensers may not be very effective absorbers. The condensers must have a sufficiently high voltage rating to withstand line voltages and the coils must have sufficient current carrying capacity to avoid overheating by the full load current of the device.

The Radio Branch, Department of Marine

The methods used by the Radio Branch, Department of Marine, Ottawa, in locating and suppressing interference have been very fully covered in the March, 1931, issue of this

Bulletin, page 80: "Public Utilities Reduce Radio Interference" by Mr. H. O. Merriman.

For tracing down interference, the directional loop aerial and the probe antenna are particularly noteworthy, the latter having been developed by the Department and proving valuable in locating the particular conductor carrying the greatest interference.

For suppression of interference caused in the normal operation of electrical appliances, emphasis is placed on the surge trap, and connection diagrams of several standard types of surge traps are given; these differ somewhat in arrangement of component parts but all serve the same purpose of preventing the surges or sudden impulses, from running along the supply lines and spreading interference.

Where the interference is traced to faults in equipment or supply circuits, a surge trap is not the proper cure; the removal of the fault should be all that is necessary.

In addition to interference from appliances, the Department is interested in interference radiated from power lines. The Laboratories have co-operated with the Radio Branch on several occasions in tracing interference and the subject is quite large enough to demand considerable attention. Interference of this type will be discussed in the next issue of the *Bulletin*.

—*F.K.D.*

Precautions in Setting Poles

By H. A. Martin, Chief Engineer, Peoples Light and Power Company

POLITENESS and consideration of customers is most important in every kind of business. In general, public utility employees recognize this fact better than those in some other industries, but there are other businesses which make courteous consideration of customers a major requirement of employees. One of these is the chain store.

Let us look in upon garrulous, grouchy Grandma Graham as she gets her supply of groceries at the chain store. The clerk comes out and puts the box in the tonneau of her car while she gossips with an acquaintance. At the last minute she sees the packages in the back seat and tells the clerk to move them to the front. In complying with her wish the clerk breaks open and spills a bag of rice into the car. He apologizes, returns to the store and brings her three more pounds of rice than he spilled into her car. Thus, he makes a permanent customer for his company.

When we set poles we must not only strive for low-cost construction but give the customer or property owner the consideration he deserves. Poles should be set so as not to interfere with drives, fire hydrants, building entrances or other features. Where reconstruction is being done in business districts the poles should be set in the rear alleys if economically feasible. This permits better results

from street illumination of the "Whiteway" type. Where trees line the streets customers are better pleased if the poles are located on the rear lot line. When poles are set along the street the location should be as near as possible to the property line between the lots. This location facilitates running "services" without interfering with driveways and entrances.

More and more the progressive utility is setting poles "in the easement" on the back property line. Here it is difficult to erect the pole without doing some little damage. We must be careful not to "spill the rice"; in other words, we must not spoil the garden, shrubbery, lawn or outbuildings. In setting poles on the consumer's premises see that all the earth removed is replaced around the pole. If the removed earth would spoil the appearance of a flower bed or the lawn place it on a tarpaulin until it is replaced.

Usually it is not necessary to paint poles, but in some cases this is advisable to avoid criticism. Green paint is often preferable for its looks and long life. Do not try to paint over creosote. If the pole is creosoted, first give the creosote a coat of aluminum paint and then one coat of the color. It takes two coats of colour properly to coat a new pole and the aluminum does not cost any more than the colour and may be used on any kind of pole and will furnish a good primer for the color coat.

In locating terminal poles for cables great care should be taken to see that they are located in such places that they are not likely to be moved, since it is not easy to move the pipes and cables. Choose the location of the poles with the property owner if he is at home. This will make him realize you consider his interests and will help frequently in getting the location you want. Consult Mr. Graham where possible and leave Mrs. Graham to tend to her rice boiling, but keep in mind Mrs. Graham's wishes.—*Electrical World.*

Some Interesting Aspects of the Hydro System

Including an Historical Review of its Policies and Achievements and a Consideration of the Lessons to be Learned Therefrom.

By F. A. Gaby, D.Sc., Chief Engineer.

(Address to Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Ottawa, June 26, 1931.)

PART II

TURNING now to another important aspect of Hydro service, it is unnecessary for me to say to a gathering of this kind, that we believe we may justly claim that, in our effort to serve the people of Ontario, and under the leadership of Sir Adam Beck, his associates and successors, a notable measure of success has been achieved. This success we are accustomed to attribute in large measure to certain basic principles which have been followed, and I believe it will be profitable in the light of the historical review that has been made, to see if we can recognize clearly and definitely just what some of these basic principles responsible for success have been. Such a recognition will be the more valuable in that both in the past and at the present time there appears to have been some confusion created in the public mind, as a result of assertions from various quarters that basic principles were being departed from.

To this gathering it is not necessary to enlarge upon such factors contributary to the success of the undertaking as:—the maintenance of harmonious relations between the co-operating municipalities and the central commission, based upon mutual confidence; the splendid support given by the citizens themselves to the enterprise; the loyal and competent staff that throughout the years has consistently functioned for the good of the undertaking; the pioneer work of its research engineers, and other scientific workers, or the effective leadership given by Sir Adam Beck, Mr. Magrath and Mr. Cooke and the special aid of other public-spirited citizens throughout its twenty-five years of history. Rather do I wish to direct attention to certain administrative policies and the practices which result therefrom.

Examination of the Commission's past activities points to four such outstanding features which have consistently characterized the Commission's history. *First* is the principle of service at cost—a feature which deserves special consideration and to which I intend to refer again presently.

A special request has been made for the publication of Dr. Gaby's address comprehensively reviewing the work of the Commission. There is published in this issue the second of three instalments which will present the complete address.

The first instalment appeared in last month's issue. It reviewed briefly the history of the undertaking with particular reference to the provision of low-cost power supplies, and showed how the history of the growth in consumption and in the supplies made available to meet demands, constitute a criterion for the future.

Second, from the commencement of its operations and throughout its history, the Commission has realized that in any comprehensive system for the supply of electrical energy to a large territory, the ownership of the transmission lines and franchise rights for distribution, rather than the ownership of the power developments, is the dominating factor. Consequently, from the commencement of its operations, the Commission proceeded to construct its transmission networks, and the municipalities to acquire or construct their distribution systems. This basic principle has perhaps sometimes been lost sight of in certain discussions respecting provisions for future power supplies. Nevertheless, its importance in contributing to the past success of the undertaking has been such that it should be recognized as a feature which in future activities will be an equally effective safeguard.

An incidental but important advantage characteristic of the "Hydro" organization from its inception may here be mentioned. The co-ordination of the systems under one control has effected important economies in administration, and the interconnection of transmission networks and generating stations has resulted in more efficient and economic operation of the whole undertaking by enabling advantage to be taken of the diversity of the various connected loads. Similar action is now being taken in Great Britain in connection with what is known as the "grid system" by means of which all sources of power supply are to be controlled through one organization. The process may further be illustrated by the combining and merging of many systems which is taking place in the United States under the name of "super-power" systems.

Third, it has been the policy of the Commission throughout its history to assure for the municipalities ownership in the power developments also, whenever such ownership could, in view of existing circumstances, be effected to the advantage of the municipalities concerned.

Fourth, a large element in the success of the undertaking has been the fact that its administrators in making their provisions for power supplies have been permitted to survey all the possibilities from time to time and to select that source—whether it might have been coal, oil, gas, water-power plants to be constructed, existing hydro-electric plants to be acquired, or power to be purchased—which at the time and under the circumstances prevailing offered the greatest advantages to the system.

Observing in the history of the Commission the provisions which have been made for power, it is to be noted that the initial supplies were purchased from the Ontario Power Company, the Ottawa and Hull Power and Manufacturing Company, the Kaministiquia Power Company and the Simcoe Railway and Power Company. These purchases were not made because of any general principle having been established that purchased power was superior to ownership of the power plants, but simply because after careful survey of all possibilities and circumstances then existing, the course adopted was judged to offer the greatest advantages. The Commission would have

liked, for example, even when initiating in the Niagara system its public service, to have constructed its own power development at Niagara, but, with the extensive water concessions that had already been granted to private interests, and the special difficulties which would have had to be met, the overcoming of which would have consumed considerable time, it was concluded best, in the interests of the municipalities, to accept the tender of the Ontario Power Company. Consequently, a contract was made for the delivery of power at 12,000 volts, and at a cost range of $9.40 to $9.00 per horsepower per year.

Owing to the fact, however, that in the initiation of its electrical service the Commission had purchased its power supply, many regarded the subsequent proposal of the Commission to construct power developments and to generate its own power, as a departure from the basic doctrine upon which the undertaking had been started. Thus, when the Commission proposed to construct its first power plant at Wasdells Falls on the Severn River, considerable opposition was encountered, and it was some time before the Government was willing to give its sanction for the Commission to proceed. Eventually, however, this was granted and the construction of the Wasdells plant marked a new step in the progress of the undertaking, but no change in the policy of the Commission. This circumstance is of special interest at the present time in view of the fact that the Commission has found it advantageous for a time again to purchase certain large blocks of power—a practice followed by Sir Adam Beck and his colleagues in the initiation of the undertaking and since, from time to time, as circumstances and the interests of the municipalities required.

Almost concurrently with the coming into operation of the Wasdells plant, the Commission adopted in the Severn system a third type of procedure with respect to power supplies—that of acquiring ownership in the power plant from the power company by which it had been built and initially operated. Here, again, this step did not mark a change in the policy of the Commission, but simply an adherence to the basic principle of selecting from among the possibilities offered, that action which would afford the needed power in a manner to yield the greatest advantage to the municipalities.

As has been seen, the subsequent history of the Commission records how all these three methods of power supply—purchase of power, construction of hydro-electric generating plants, and purchase of hydro-electric generating plants—have been utilized from time to time in varying degree, the deciding factor in each case being the interests of the municipalities at the time and under the circumstances existing. As additional methods, there have been instituted reciprocal agreements for interchange of power between plants and, for a time, even the purchase of power from organizations in another country. Under some circumstances it has been found advisable to make temporary purchases of steam power, and to operate fuel electric plants acquired or installed by the Commission. In a

word, the basic principle of flexibility with regard to the measures that might be adopted to provide power requirements, has been one of the outstanding features of the Commission's policy.

Recent Actions Conform to Established Principles

The course pursued by the Commission in more recent years has simply been a continuance of this broad and basic policy which had contributed so much to past success. In this connection I should like to revert for a moment to 1922 when the Queenston-Chippawa development was just beginning to deliver power. Even at that time the Commission was looking for new sources of power supply and in 1923 was seeking to negotiate for power from the Ottawa and Gatineau watersheds, and also considering where it would be best to establish new transmission lines in order to protect the interests of the people of the Province, and a definite offer was made for an ample supply of power at $15.00 per horsepower.

Gatineau Power Company

The Gatineau Power Company is a subsidiary of the International Paper Company. It develops power at three sites on the Gatineau River, Farmers Rapids, Chelsea and Paugan Falls. Twenty-five-cycle power developed at Paugan Falls is delivered to the Commission at 230,000 volts at the interprovincial boundary near Chats Falls on the Ottawa River, 30 miles from the generating station. From there it is transmitted over a transmission line 203 miles long, constructed and owned by the Commission, to a transformer station at Leaside on the outskirts of Toronto. The contract for 25-cycle power made in 1926 is for 260,000 horsepower at $15.00 per horsepower per year. The first block of power—80,000 horsepower—was delivered in 1928 and power was made progressively available in blocks until the whole amount contracted for was taken, somewhat in advance of the time arranged.

Incidentally, it may be pointed out that some hypothetical comparisons of costs have been attempted which overlooked, among other important factors, those of step-up transformation to 220,000 volts and of transmission to the boundary —in the case above mentioned a distance of about 30 miles. Also, there have been ignored the benefits derived by the Hydro undertaking from the contract conditions permitting the taking of power as utilizable, thus avoiding such losses as usually occur during the period of building up load.

St. Lawrence River Power

Even before consummating these agreements, the Commission had made effort to secure authority to build its own power plants on the international portion of the St. Lawrence River, and again in 1924 the Commission filed with the Dominion authorities tentative plans in the hope of having its application favorably considered. It was hoped also that the various international, national, state and provincial interests could be brought together, difficulties removed and a broad programme acceptable to all interests concerned agreed upon. In fact, almost since

its commencement, as early as 1913 and since, the Commission has been conducting investigations relating to the St. Lawrence River, looking forward to the time when Ontario's share of the power in the international section of the river could be developed. In the effort to hasten the availability of power the Commission from time to time has directed attention to the fact that the power on the international section of the river could be developed independently of proceeding with the full development of the St. Lawrence waterway as a deep-water navigation route from the Great Lakes to the Sea. Thus, in its representations to the International Joint Commission in 1921, the Commission states:

> "The economics of the improvement of navigation in the St. Lawrence is a phase of the problem which the International Joint Commission has taken special means to determine, and consequently the Hydro-Electric Power Commission has not specially dealt with this subject. The Commission's researches, however, have conclusively demonstrated that hydro-electric development of the St. Lawrence River can be carried out in such manner as to justify its development from the standpoint of power production alone, while at the same time providing that the physical structures required for power shall embrace all features necessary to safeguard the present and future requirements of improved navigation."

The Commission's extensive report to the International Joint Commission in 1921 was presented in connection with the St. Lawrence Reference made to that Commission by the two Federal Governments concerned. The International Joint Commission reported in 1922. The two Federal Governments, in 1924, submitted the St. Lawrence problem for further investigation and report to National Advisory Committees and in 1925 the Government submitted the St. Lawrence problem for consideration by a Joint Board of Engineers. These engineers submitted their first report in 1926. The Governments have called for still further investigations and these demand serious consideration of international and other problems involved, but not yet solved.

Governor Roosevelt in 1930 appointed a St. Lawrence Power Development Commission to report upon St. Lawrence problems as they affect the interests of the State of New York. This Commission reported in January, 1931. Later, action was taken by the New York State legislature. Just recently the Governor's St. Lawrence Power Development Commissioners were superseded by a new personnel to which have been entrusted further investigations, and the authority has been conferred to enter into discussions with other Governments concerned with the ultimate object of agreeing upon some programme that will contribute to the harmonizing of the various interests concerned, and hasten the time when New York State may secure its share of power development from the international portion of the St. Lawrence.

I simply refer to these various operations of the last ten years in

order to show that the St. Lawrence problem presents many difficulties. The Hydro-Electric Power Commission has fully appreciated these, but the Commission, as recently pointed out, "has sought, wherever possible, to hasten by study, representation and co-operation, the development of Ontario's share of St. Lawrence power. At no time, however, has the Commission had sufficient authority to enable it to proceed with the development of Ontario's share of the St. Lawrence River power."

In connection with this development of the St. Lawrence, I may add that the evidence of engineers has been that from five to eight years would be required to complete such a development. The Hydro-Electric Power Commission believes that it could not reasonably hope, even assuming that the St. Lawrence development were commenced at once, to obtain its supply of power from this source for from six to seven years. The St. Lawrence site, therefore, could not be counted upon as a source of immediate supply to meet the power demands with which the Commission was faced.

Niagara River Power

Additional power may be developed from the waters of the Niagara River, but as in the case of the international portion of the St. Lawrence, the Province of Ontario is not able independently to construct the necessary works. When the Boundary Waters Treaty of 1909-1910 was ratified, its Article V. allotted 56,000 cubic feet of water per second for power purposes. It has long been recognized that, in conjunction with certain works designed to secure a more uniform distribution of the flow of water over the crest of the Falls, further water could be appropriated for additional power development, with benefit to the physical preservation of the Falls as well as to their scenic beauty. A special Board, comprising both Canadian and United States representatives, was appointed to investigate fully this phase and its report was duly submitted in December, 1929. Based on this report authorities in both countries subsequently prepared a proposed Treaty, which, in 1929, was agreed to by the Dominion Government, but upon presentation to Congress at Washington was rejected by the United States Senate, in January, 1931, some two years later.

Until some concurrent action is taken by both countries concerned, the Hydro-Electric Power Commission cannot hope that further allotment of water will be available for the development of Ontario's equity in the power supply from the Niagara River.

Power from the Ottawa River

At the Chats Falls and other sites on the Ottawa River, there existed up until 1927 a serious menace in the form of what were claimed to be rights and privileges possessed by the Georgian Bay Canal Company, and it was not until 1927 that the Federal Government dealt so definitely with this situation as to clear the way for the Hydro-Electric Power Commission to co-operate in the power development at Chats Falls. Then, just as soon as it was possible to consummate the necessary arrangements with the owners of the Quebec half of the power site at Chats Falls,

the development was placed in course of construction, providing for the Commission from its own development 96,000 horsepower, becoming available in 1932, and also 96,000 horsepower from the Quebec half of the plant. That is to say, the Commission in connection with the Niagara, the international portion of the St. Lawrence and the Ottawa River water powers has spared no efforts to carry out its basic principle of obtaining power by preference from its own developments; and when at Chats Falls the obstacles which hitherto had prevented development were removed, it lost no time in actually constructing its own power development.

In the case of the Carillon site, even at the present time, the Commission would be unable to proceed until, by Provincial lease or otherwise, the authorities of the Province of Quebec should release to the parties interested in that Province the Carillon rights for development.

Steam Plants Considered

Throughout this general period the Commission from time to time considered the desirability of developing power from steam. In the earlier period there was a considerable differential between the cost of steam electric power and hydro-electric power in favor of the latter and during consideration of the Gatineau contract it was shown that for the delivery of power to the Niagara system at Toronto there was from $7.00 to $8.00 in favor of the Gatineau power and against the cost of producing a like quantity of steam power. During recent years, however, this differential has been lessened, although even yet there is still a margin in favor of electric power produced from water under favorable conditions. There are also other important considerations to which the Commission has given weight, such as that of not depleting the wealth which would remain in Canada, by avoiding the making of expenditures in another country for coal to be imported into Canada, and also the dependence upon fuel, the cost of which might be seriously affected by interests not under the jurisdiction of the Commission. An increase of $1.00 per ton in the price of coal would increase the cost of electrical energy by at least $2.50 per horsepower at 70 per cent. load factor.

Purchase of Power Necessary to Prevent Shortage

When, in 1926, it became clear that circumstances outside its control would prevent the obtaining of authority to proceed with construction of new plants on the St. Lawrence, the Niagara and the Ottawa Rivers in time to provide for the increased demands of the municipalities, it was recognized that recourse must be had to other sources to meet the needs. Just as the Commission, when confronted with a situation at Niagara Falls which in 1908 prevented construction of a publicly-owned power development for the municipalities, surveyed all the alternative possibilities and selected the purchase of power as the most advantageous course, so the Commission's history has repeated itself. Choosing between having recourse to relatively small or too distant water powers in Ontario, to construction of steam plants in Ontario, or to purchase of

low-cost power available from projected hydro-electric plants across the inter-Provincial boundary in Quebec, the Commission selected the course which offered the greatest advantage to the municipalities—a course which, as it happens, parallelled the original course taken by Sir Adam Beck, in that power was purchased on advantageous terms from private companies. The Beauharnois contract consummated in 1929 provided 250,000 horsepower, and subsequently, in 1929, arrangements were made for 125,000 horsepower from developments on the Lievre River.

Beauharnois Power Contract

In the case of the Beauharnois contract it is, I trust, unnecessary for me to assure an audience like this that some of the representations with respect to this contract that have been publicly made are entirely without foundation. The situation simply was that, in the absence of any assured possibility of obtaining adequate additional supplies of power from the international section of the St. Lawrence, the Niagara or the Ottawa Rivers, and with the Gatineau contract for 25-cycle power in process of such rapid absorption, Beauharnois power offered the most advantageous means of providing for the imperative needs of the immediate future. I may point out the very significant fact that, if this contract had not been consummated, in place of now having an assured position with 450,000 to 500,000 horsepower of low-cost power available to care for the growth of load in the next six years, there would have been but 200,000 to 250,000 horsepower of such power available for Ontario, and the situation might indeed within a very short time have become one of definite power shortage or of increase in the cost with dependence upon imported fuels. It is well to remember also, that in 1928 and even up to the latter part of 1929 many outstanding leaders in all spheres of activity anticipated an indefinite continuance of the ever-accelerating pace at which industrial activities had been expanding since 1922, and that it was incumbent upon the Commission to be prepared even for such an eventuality, should it materialize. Had the 1929 pace of expansion continued, it would have been necessary to supplement further the provisions that have actually been made.

Price Paid for Purchased Power

With respect to another phase of the public discussions that have taken place regarding purchases of power, the Hydro-Electric Power Commission pointed out in its recent formal statement of May 6th:

> "A word may be added respecting the criticism that has been made with regard to the price paid for purchased power. Having in mind the fact that statements have been quoted from prospectuses of private power companies, purporting to show that their contracts with the Commission are of a character specially advantageous to the companies, it is sufficient to say that the Commission is not responsible for representations made by others in prospectuses or in the public press. The price which the Commission on behalf of the municipalities was prepared to pay

for its purchased power was determined upon independent investigation of facts and the knowledge of what would be a reasonable price to pay for the power, taking into account the factors which enter into the cost of its production and marketing; and in this connection it is well to remember that expenditures under private development involve costs and methods of financing quite different from those which govern under the operations of the Hydro-Electric Power Commission of Ontario. It is not possible to make proper comparisons without bringing all important technical, economic and other circumstances to a comparable basis."

By way of illustration, when a representative of the Georgian Bay Canal Company offered to sell the Commission Ottawa River power at a cost of $19.00 per horsepower per year, the Commission from its own knowledge of factors entering into the cost of power was able to determine promptly that such a quotation was unreasonably high.

In 1915, the Commission considered that the contract with the Canadian Niagara Power Company at $15.00 per horsepower at the generating terminals represented market value at that time. In the case of the Beauharnois contract the power is to be delivered to the Commission at the inter-provincial boundary, some twenty-five miles from the generating plant. The cost of stepping up from generator voltage to 230,000 volts for transmission, and transmitting twenty-five miles, is included and, would be from $1.50 to $2.00 per horsepower. After taking all essentials of cost into consideration, the result of introducing Gatineau power into the Niagara system has been to lessen the average cost of power to the co-operating municipalities.

The executives of the Commission have considered and dealt with costs of power under the purchase contracts in the same way that they have dealt with other matters, namely, to appraise the various factors entering into costs on their own independent bases and to arrive at conclusions respecting what cost would be reasonable for all interests concerned, while at the same time being advantageous to the municipalities whose citizens, in the last analysis, need and will use the power and pay the cost.

Thus the circumstances with which the Commission has recently had to deal in connection with power supplies may broadly be summarized as follows:

First, large quantities of power for use in the immediate future must be provided if Ontario's development is to proceed unhampered. *Second*, notwithstanding its most earnest efforts, the prospect of obtaining authorization to proceed with development of St. Lawrence power, in time to have the power ready when needed, has continued indefinite. *Third*, in order to obtain additional power from Niagara River, the additional diversion of water required involves treaty provision to which the United States Senate, as yet, has not agreed. *Fourth*, until 1929, factors outside the Commission's control prevented development of its inter-provincial powers on the Ottawa River, and, even yet, further development at certain important sites is not

immediately possible. *Fifth*, other sources of hydro-electric power of adequate magnitude in the Province of Ontario were relatively distant from the areas of consumption. *Sixth*, it would be possible to obtain power by the construction of coal-burning steam plants, but the features of dependence upon foreign sources for fuel, and loss to the country through payments of money going abroad, were factors, among others, which made construction of steam plants at this period inadvisable. *Finally*, sources of low-cost hydro-electric power were available in the neighboring Province of Quebec, which the controlling interests were willing at this time to make available for use in Ontario on terms fair to all parties concerned.

In a word, being prevented by circumstances beyond its control from utilizing, as yet, the sources of large power supply it would have preferred to develop, the Commission in accordance with the policy which has actuated it from the commencement of its history, simply chose from among the remaining possibilities those sources which were most advantageous to the municipalities—namely, purchase of power from Quebec, and—as soon as it became possible—development of the Commission's own power site at Chats Falls.

Franchise Rights Recently Acquired

Now, just as it has been seen that, in its recent actions with respect to providing for power needs, the Commission has followed the same basic principle of flexibility of procedure that had contributed so greatly to the past success of the undertaking, so also with respect to the second of the basic principles that have been enumerated—that of assuring for the municipalities control of transmission and distribution facilities, rights and franchises—the Commission's recent actions have been a continuance of established policy.

Thus, with regard to the Dominion Power and Transmission Company which the Commission purchased in 1930 for $21,000,000, it may be stated that proposals involving these properties had been under consideration for some time, but it had not been practicable to consummate agreement for purchase until various important difficulties were removed. This corporation had an extensive and favorable market for electrical service involving some large contracts for the supply of power.

The plant at Decew Falls was an important power site, with reservoirs which could be enlarged so as to render a very desirable and efficient function in connection with the operation of the Commission's other Niagara system plants, and will enable the Commission when conditions warrant, to establish, with the reservoir capacity available, a peak load plant of from 200,000 to 250,000 horsepower. As pointed out by the Commission at the time in a formal statement given to the public press, it is the intention to dispose of the bus and railway lines. After reviewing all the circumstances, it seemed to the Commission best to acquire these properties in 1930 when general economic circumstances contributed to make all parties concerned willing

to come together for the consummation of an agreement, and further it seemed desirable to eliminate the possible future economic waste which would result from an increase of investments for developments at a frequency different from that of the Niagara system.

In addition to the purchase of these properties, the Commission, as you know, purchased in 1929 the power developments, transmission lines, distribution system, franchises and water-power rights in the Madawaska district which are now part of the Eastern Ontario system.

In 1929, it also purchased a controlling interest in the Wahnapitae Power Company which comprises similar assets including three water-power developments on the Wahnapitae River. These properties form the nucleus of the Sudbury district of the Northern Ontario system.

In 1929, it also purchased the assets of the Bala Electric Light and Power Company including two small power developments. The possession of these plants will be advantageous in the operation of future developments on the Muskoka River. They serve small but important districts which are now a part of the Georgian Bay system.

In 1930, the Commission acquired the properties in Bruce County owned by the Foshay interests. These include three power developments and certain transmission and distribution lines, etc., formerly owned by the Saugeen Electric Light and Power Company and the Walkerton Electric Light and Power Company.

In 1930, the Commission acquired certain rural lines known as the Beach Rural Electric system. These have been consolidated with the Eastern Ontario system.

While the power developments secured with these purchases are in some cases relatively small in magnitude, the purchase of the properties as a whole are important elements in the carrying out of the dominating policy of ownership of distribution systems and franchise rights, and in safeguarding the ownership of other water power sites for future developments. Furthermore, through the acquisition of the properties just referred to, the Commission has made notable progress in extending "Hydro" service to areas which had not previously participated in the undertaking.

(To be Continued)

Uniform Accounting---Hydro Shop

By W. B. Munroe, Municipal Auditor, H.E.P.C. of Ont.

(Introduction to discussion by Accounting and Office Administration section of Association of Municipal Electrical Utilities at Ottawa, June 26, 1931.)

OUR Hydro Shop uniform accounting system is, I believe, fairly sound, but under changing conditions should be subject to scrutiny, and, if possible, improvement, in the same way as we continue to endeavor to improve our Uniform Standard Accounting System for Utilities.

A great deal of time need not be spent on bookkeeping and records, but some time should be spent on these every day. Many of the most successful businesses spend two or three per cent. of net sales on accounting and other records. A few spend as much as five per cent. Lack of information costs more because of the waste and other losses it causes.

The uniform system of Hydro shop accounting is used in both large and small shops, and many municipalities where a small business is carried on have frequently spoken of the enormous amount of time entailed in keeping the necessary records with all the time spent on the bookkeeping system, a number of shops still have difficulty reconciling the material account with the actual inventory. Where a considerable investment is made by the utility in the appliance business it is absolutely necessary that we keep proper records.

The operating charges as shown on the Annual Statements of Hydro Shops would, in many cases, convince an outside critic that discrimination was made in splitting charges between the Utility and the shop, and in some instances there may be a little truth in the assertion. It is difficult, however, to make intelligent charges, for in many instances, when a purchase is made of stationery or office supplies, one cannot tell whether they will be used on a 50–50 basis or a 75–25 basis. Likewise, in some shops, difficulty is experienced in getting a proper split on labor where the men are not careful in making up the distribution of their time. Servicing is an item which could undergo much useful discussion, and in quite a number of cases we find that some use might be made of a truck which is not charged. Interest on the investment is a large item in our operating charges and our present method of charging interest on the average inventory and accounts receivable has been questioned on a number of occasions.

The splitting of expense items in most cases must be left to the discretion of a responsible party in the office, but an item such as interest is a fixed charge, and is correct, providing the basis on which we determine the capital investment is fixed. There are some delegates here who have given much time and study to shop accounting and I feel sure that if we confine ourselves to a discussion of this basis of capital investment on which the interest charge is based, an important point in Hydro Shop

accounting might be settled at an early date.

In order to begin a discussion on the question of the annual interest charge and how the investment should be arrived at, I might say that my contention is that the amount of capital actually in use during the year, is the figure we should use. This figure would comprise the average inventory, the average accounts receivable, and the cost of equipment. I have endeavoured in my own mind to justify the claim that previous years accumulated profits should be deducted from this investment figure, but so far I have been unsuccessful.

Deducting accumulated profits from the actual capital used during the year looks to me like a legacy to the shop each year, and in competition with electric appliance shops, grossly unfair.

General Practices re the Use of Depreciation Reserve

By D. J. McAuley, Municipal Auditor, H.E.P.C. of Ont.

(Introduction to discussion by Accounting and Office Administration section of Association of Municipal Electrical Utilities at Ottawa, June 26, 1931.)

THE depreciation reserve, as we call it, I think is misnamed. It is really a reserve for renewals, obsolescence and contingencies and should be charged with all external maintenance which cannot properly be charged against the current year's operation. In my opinion, operation should not show any great difference but should be practically the same year by year, always taking into consideration additional capitalized inventory. Original capital should be charged to the reserve, that is, of course, less any scrap value or anything that can be used again, which should be charged up to stores, and of course credit will be given for it when it is used again or when it is sold. But old capital should be taken out entirely and credited to its respective capital account, and the new outlay charged to capital. Extraordinary maintenance, such as we get in a lot of municipalities, such as damage from heavy sleet storms, sometimes burning out of sub-stations (which cannot by any stretch of the imagination be charged to current year's operation), should be charged against reserve rather than against the current year.

It is quite apparent that if large unforseen expenditures in regard to such things as sleet storm damage, burning out of transformer stations, etc., are always charged up to current year's operation, it may be just possible that in the previous year, through a nice surplus, retail rates are reduced and then, in the next year, you get these unforeseen expenditures charged up to operation, and it will immediately, instead of having a surplus, cause a deficit. Depreciation reserve, as we call it, should be a stabilizer on our maintenance account and should take all just charges which cannot be allocated against the current year's operations.

Straightening a large 30 inch Generator Shaft and Aligning Bearings

By A. S. Robertson, Operating Superintendent, Queenston Generating Station, H.E.P.C. of Ont.

(From a paper read before Toronto Section A.I.E.E.)

WHILE operating at full load the upper guide bearing failed on one of our generators and before the unit could be shut down serious mechanical damage was done to certain mechanical parts of the generator.

The bearing, having wiped on one side, permitted the shaft to swing and rub against the stationary oil catcher which is located immediately below the upper guide bearing. This rubbing produced local heating on the shaft which in turn bent the shaft.

In addition to damaging the thrust collar, exciter deck and oil catcher, this rubbing left the shaft with a permanent bend of .022 in. in a length of 36 ft., about 18 in. from the top of the rotor. It is interesting to note that the clearance between the exciter deck and the thrust collar, some 6 ft. above the bearing, is approximately $\frac{1}{8}$ in., yet the top of this shaft during the rubbing stage bent sufficiently to strike against this deck.

The repairs to the deck and thrust collar were easily solved, by using the welding machine on the deck and shrinking a collar on the damaged section of the thrust nut.

However, the straightening of the 30 in. shaft, which with its rotor and field pole assembly weighing 320 tons, was an entirely new problem to our staff. The general accepted method was to turn the rotor on its side and support the shaft in a horizontal position between two temporary bearings. The turning of the rotor completely assembled was impossible with our crane capacity. After considerable discussion as to the best method and after this discussion had brought out very plainly that the only reason for turning the shaft was for measurement purposes, we decided to make the attempt leaving the shaft in the vertical position.

Checking Shaft Vertically

Due to previous experience in checking shafts in this position, we felt that we could check the shaft with sufficient accuracy to insure success in this position.

Two boards at 90° apart were mounted on the top of the shaft to form four outboards. From each of these four outboards was hung a piano wire plumb line. These outboards kept the four plumb lines at a definite distance from the surface of the shaft and also permitted the plumb lines to pass through holes in the rotor to extend the plumb lines to the coupling on the bottom of the shaft. By means of a micrometer pin gauge, readings were taken between the four plumb lines and the surface of the shaft at sufficient intervals along the shaft between the top and bottom as to properly determine the variation in the shaft from a straight line.

Measuring to Plus or Minus .002 in.

To insure greater accuracy in taking these readings, the pin gauge was fitted up with a telephone receiver and a dry cell so that every time an electrical contact was made with the gauge and the piano wire a click would be heard in the telephone receiver. This insures the minimum pressure on the plumb line by the pin gauge, that is, that it touches the line but does not disturb it. An experienced reader can easily obtain results to within a variation of plus or minus .002 in.

This method of measurement had the further advantage that it was not necessary to plumb the shaft and rotor assembly before taking the readings. The plumb lines are hung and the slope per ft. is determined, after which the readings are taken in the ordinary way and these readings are corrected for the slope to give the true reading.

Having determined the location of the bent portion of the shaft and the amount, the next step is to straighten the shaft. The method of straightening consisted of heating the shaft on the outside of the bend which, when it has cooled, will set up a shrinkage stress sufficient to pull the shaft back into line.

To do this satisfactorily it is essential to apply as large a volume of heat and in as short a time as is possible. This is to create a local heating and to prevent the heat being conducted around the shaft to the other side. After heating, the shaft is left to cool naturally for about 24 hours.

The success of this method of straightening shafts is based on the theory that the application of a localized heat softens and upsets the metal at the point of application.

Fig. 1—Applying heat to generator shaft

Due to the localized upsetting there is less resistance to shrinkage strains and hence the shaft shrinks the most at this point. This causes the shaft to retract further than its outward movement due to the applied heat. The reverse cycle took place in the first instance in causing the shaft to bend, with the only difference that in the straightening we attempt to control the heat and thereby control the shrinkage so as to just bring the shaft back into line.

The set up for this, shown in *Fig. 1*, consisted of 2 large Hauck coal oil burners which are equipped with a 2 in. nozzle on the torches. A baffle consisting of a couple of building tiles and some asbestos paper were used at the shaft to localize the flame. A

very careful procedure for handling the torches had to be worked out as you will see from the photograph that the working space is very confined and these torches throw an exceedingly hot flame. Each operator of the torch has to have a definite understanding of how he is going to swing the torch, after he has started it in the bucket, and then swing it to the shaft.

The duration of the heat and the amount of deflection required for a given bend is largely guess work and one or more attempts usually are necessary before getting the required results.

From the experience of other organizations we were advised that after three heats on the one spot very little would be gained and it is better to move to another spot above or below the previous place. The greatest deflection will be from the first heat and each successive application on this spot produces less results.

In this case we obtained our objective in two heats. The first application of heat was made for 10 minutes, which, while being applied, caused the top of the shaft to move about 1/16 in. further in the wrong direction. Upon checking the next day it was found that the bend had been reduced by .004 in.

After 24 hours had elapsed from the first application of the torches, a second application was made, lasting 15 minutes. At the end of the 15 minutes period the top of the shaft had moved 3/16 in. (as determined from the plumb lines measured at the coupling) in the wrong direction.

After a further cooling period of 24 hours the straightness of the shaft was checked and found to be within .007 in. at the top and .0025 in. at the bottom, *i.e.*, over a distance of 35 ft. 7 in. which was deemed to be near enough for practical purposes.

From this experience it may be said that had the first application been applied for 15 minutes we would probably have secured the desired results in one heat. Further, it will be seen that the biggest problem is in the measurement of the shaft to determine its straightness, and when this is solved the job becomes relatively simple.

Each time a generator unit in the Queenston station (or any other H.E.P.C. of Ontario stations) is dismantled for a major repair, the alignment is checked. These units, *i.e.*, turbine and generator, consist of two guide bearings in the generator and one guide bearing in the turbine. To check the alignment of these three bearings requires a 45 ft. steel piano wire with a 50 lb. plumb bob suspended on the end of the line. The plumb bob is also placed inside a large pot filled with oil to act as a damper. There are so many disturbances about a powerhouse that it is necessary to use such a heavy plumb bob and an oil pot to damp out the sympathetic oscillations of the line.

This line is centralized in the upper generator bearing and dropped through the other two bearings. The readings are taken with a micrometer pin gauge using the same method of taking readings as described in measuring the shaft for straightness. The readings so obtained are corrected for slope and plotted as shown in the chart.

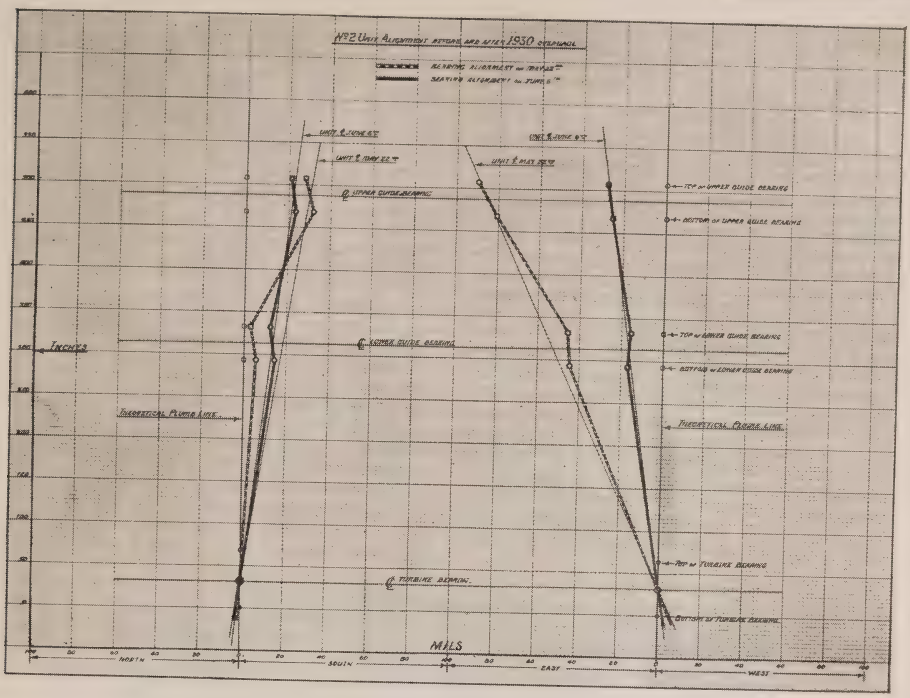


Fig. 2—Chart showing bearing alignment on a Queenston unit before and after Shimming.

The chart shows the plotted results obtained from checking the alignment of the three bearings on one of our units. The broken line indicates the condition as it was found, and the other line shown in full indicates the alignment as it was left after making the necessary alterations.

The next step is to correct the machine alignment and bring all three bearings into a common line, but not necessarily a plumb line. When these units were originally installed all three bearings were lined up to a plumb line. To-day, after, in some cases, two corrections, the general conditions of all our units are as shown on this diagram, that is to say, we have brought all three bearings into a common line which has an inclination from the true plumb line.

Naturally it might be asked why we do not plumb the unit when we make our corrections. To answer this it is necessary to consider the assembly of the unit and the relation of the various parts, the one with the other.

Starting at the bottom, the scroll case controls the lower guide bearing. This scroll case being embedded in concrete does not permit any changes at this location. The lower generator guide bearing is assembled in the lower bracket which rests on the base ring, and in consequence of this construction permits a vertical movement by shimming of the bracket, and a movement of the bracket in a horizontal about the centre line. The upper bracket rests on the generator frame and has a spigot fit

which prevents horizontal movement but it does permit, by shimming, a vertical movement.

The generator stator is bolted and dowelled to the base ring which permits, by shimming, a vertical movement and, by removing the dowels, a horizontal movement.

These are the only practical means of correcting the alignment to take care of settlement but each has its limits of use. For instance, any correction by shimming the stator and moving it about the vertical centre, requires the lifting of the 300-ton stator to place the shims and the re-dowelling of the frame in a new position. These dowels are 3½ in. in diameter and involve a great deal of work to fit, also the lifting of the heavy stator is likewise a serious task. Further, the commercial size of the shimming material places a limit on the correction possible by this method as it may be too thick and in consequence over-compensate the alignment.

It is because of these difficulties that the correction is usually made at the brackets, and in consequence, the correction results in an inclined line with respect to the plumb line.

Unless a proper study is made of the required correction by plotting the observation as shown on the chart a much greater inclination will be produced than is necessary.

For instance, if the low side is raised all on the one side on both brackets, the centre line of the bearing moves about an arc equal to a radius of half the diameter of the brackets. This means that the alignment of the two bearings is on a new line which has a different inclination than the one assumed by the unit in the first place. From a study of this chart it is obvious that if we wish to maintain the same inclination, each bracket must move in a plane whose centre is the bearing line, an operation that requires that the bracket shims be taken out on one side, and additional shims be put in on the other.

It will also be apparent that by swinging the upper bracket about one side, instead of about the bearing centre, it is possible to reduce the angle of line-up.

All Correcting Methods Used:

This chart was chosen because in this particular unit all methods of correction were used. The stator was shimmed to reduce the large angle of inclination. However, it could not conveniently be made plumb because the commercial sized shims were too thick, consequently the line-up was left with a smaller angle of inclination. The brackets were then shimmed to give the proper inclination to an approximate line-up.

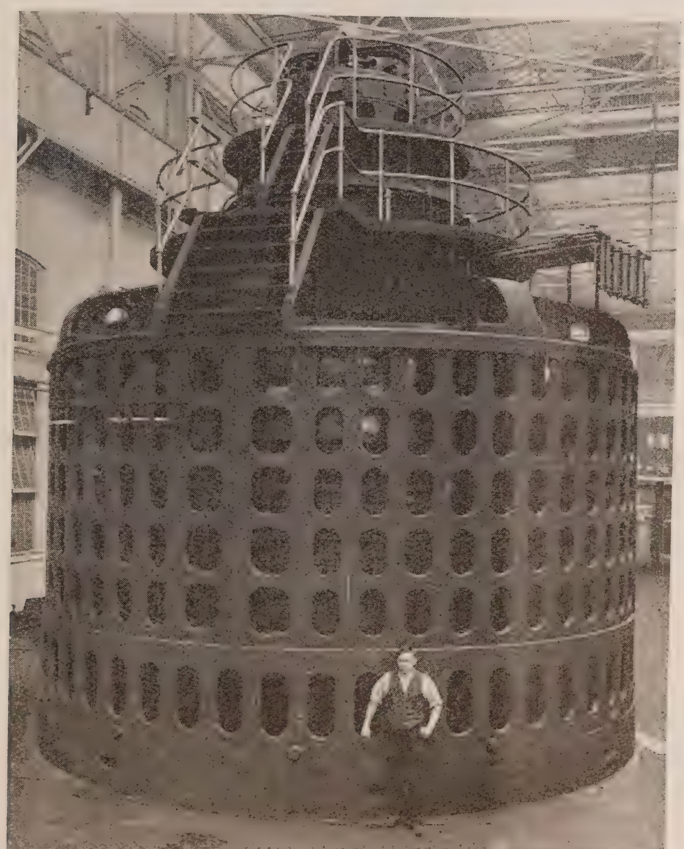
In shimming the brackets care must be taken not to seriously disturb other important points, such as the height of the thrust bearing or the location of the runner with respect to the scroll case. These conditions sometimes limit the corrections that can be made and the whole line-up must of necessity be a compromise.

The usual standard is to line-up the horizontal centre of each bearing to the line desired. As the generator bearings have a clearance of .018 and the turbine bearing .008 in., these clearances enable certain liberties to be taken in departure from a

perfect line-up over the vertical length of the bearing. This is why there exist on the chart lines indicating the vertical length of the bearings which have a different angle to the line.

Due to the heavy weights of most of these parts and the delay caused in putting in and taking out shims, an endeavour is made to calculate from these readings the thickness of the shims required for these corrections and thereby reduce the number of corrections to be made by the usual try and check method. From some of the problems which have been briefly outlined, it is apparent that such a job is one requiring accuracy in readings and full appreciation of all the items which will be affected by these changes. Because it is complicated and often confusing, such a chart has been prepared which graphically depicts the conditions before and after correction.

To line-up a new unit with all parts lining to a plumb line is a tedious process, but to re-align a unit which has been in service with so many fixed points is not only very tedious and slow, but requires greater ability and care than a new job.



HYDRO NEWS ITEMS

Eastern Ontario System

The Hydro-Electric Power Commission of Ontario has authorized expenditures of approximately $2,000 to provide increased capacity for the supply of power to Warkworth. The Local Commission is also contemplating improvements to the distribution system for the betterment of service to consumers.

* * * *

The Corporation of Trenton passed the necessary by-laws providing for the purchase of the Trenton local distribution system and substation on September 14th. A by-law was also passed on the same date, granting a gas franchise to the Lake Shore Gas Company.

* * * *

The village of Westport has completed contract with the Commission for a supply of power and arranged for the building of a distribution system. Work has been commenced of building the necessary line to Westport and of the distribution system in the village, and it is planned to have the system in operation this fall.

* * * *

Niagara System

A new 3-250 kv-a. 26.4-13.2/4 kv. distributing station with one 4 kv. feeder, but for an ultimate capacity of three feeders, is to be constructed in the near future to serve the eastern section of the London Rural Power District.

* * * *

Power was made available on September 22nd to supply a new Gypsum plant in the vicinity of Hagersville. This customer has installed a substation of 750 kv-a. capacity for the purpose of transforming its power to a suitable voltage.

* * * *

A new sub-station was recently placed in service for the purpose of serving the Guelph rural power district.

The rural power district has been changed from 2,300 to 4,000 volts, with a greatly improved regulation. This has been made necessary by a large increase in the use of electrical service during the past two years.

* * * *

A new form of line trouble was recently discovered in the Guelph rural power district at the point where the 4,000-volt line crosses the rifle ranges. This line appeared to be out of the line of fire, but owing to the trajectory of the bullets it was found at times to be in direct line. The rifle men could not understand at times why their markers reported "no hits" but upon examination by the linemen it was found the missing bullets were embedded in the aluminum cable and that the line was almost shot away when discovered.

The remedy was to increase the height of poles at this point.

It is evident that ballistic experts will have to report on lines crossing rifle ranges in future.

* * * *

On June 28th the 13,200-volt circuits on Yonge Street from Toronto to north of Willowdale were changed to 26,400-volts by means of auto transformers installed at the latter point. The sub-stations along the line were changed or altered to accommodate the use of this voltage.

The change was accomplished with a minimum of interruptions to the municipalities affected and the results to date have been very satisfactory, with much improved voltage all along the line.

Association of Municipal Electrical Utilities

Minutes of Executive Committee Meeting

A meeting of the Executive Committee of the Association of Municipal Electrical Utilities was held at the office of the Hydro-Electric Power Commission of Ontario on Tuesday, September 8, 1931. The meeting was called to order at 2.00 p.m. by the President, Mr. J. W. Peart. Other members present were: Messrs. E. V. Buchanan, T. J. Hannigan, T. W. Brackinreid, O. H. Scott, R. L. Dobbin, C. E. Schwenger, R. S. Reynolds, J. E. B. Phelps, E. J. Stapleton, C. A. Walters, H. T. Macdonald and S. R. A. Clement.

It was moved by Mr. J. E. B. Phelps, and seconded by Mr. E. J. Stapleton, THAT the Minutes of the Executive Committee Meeting of April 7th, and of the Convention at Ottawa of June 25th, 26th and 27th, 1931, as published in the *Bulletin*, be taken as read and adopted.—*Carried.*

The minutes of the Convention recorded the following resolution by the Accounting and Office Administration session: "That the A.M.E.U. Executive Committee be asked to communicate with the H.E.P.C. requesting that the operating surpluses and deficits in respect to Hydro Shops be accumulated on the books of the Hydro Shops from inception, and that these figures be taken into consideration in computing the annual interest charge against the Shops, starting with the year 1931."

Following a discussion which showed a difference of opinion regarding the suggestion contained in the above resolution, it was moved by Mr. R. L. Dobbin, and seconded by Mr. E. V. Buchanan, THAT the resolution be referred back to the Committee on Accounting and Office Administration for further discussion before action be taken on it by the Executive.—*Carried.*

Mr. H. T. Macdonald, Treasurer, advised that he had received a cheque for $200.00 from the City of Ottawa as a contribution towards the Association's Convention expenses, and asked for instructions as to its acceptance. It was moved by Mr. E. V.

Buchanan, and seconded by Mr. E. J. Stapleton, THAT the Association accept the cheque from Ottawa with thanks.—*Carried.*

The Treasurer also submitted a statement of receipts and expenditures of the Association during 1931, as a guide in arranging for the 1932 Winter Convention.

It was moved by Mr. E. J. Stapleton, and seconded by Mr. O. H. Scott, THAT the Convention Committee limit the cost of entertainment at the Winter Convention to $150.00 and dispense with attendance prizes, and make no refunds on unused meal tickets.—*Carried.*

Letters from the National Fire Protection Association, asking this Association to become members of that organization, were read and ordered filed.

Letters from the Royal York Hotel and the King Edward Hotel, Toronto, bidding for the Winter Convention of the Association, were read, both giving the dates of January 27th and 28th, 1932, as available. It was moved by Mr. T. W. Brackinreid, and seconded by Mr. E. J. Stapleton, THAT the Winter Convention be held at the Royal York Hotel, Toronto, on January 27th and 28th, 1932. —*Carried.*

In discussing the Convention arrangements it was agreed that the sessions and other functions should be held as formerly, *i.e.*, Convention luncheons on each day and a dinner on the evening of the first day, the luncheon on the first day to be with the Electric Club of Toronto. There will be a short business session on the morning of the first day, and the usual convention sessions on that afternoon, and morning and afternoon of the second day. Mr. Hannigan asked that a part of the time be devoted to subjects of interest to the Ontario Municipal Electrical Association and which would be instructive to all delegates.

It was moved by Mr. O. H. Scott, and seconded by Mr. T. W. Brackinreid, THAT the meetings of the Accounting and Office Administration section be held in the general sessions, meeting separately in committee and bringing in its recommendations for discussion at general sessions: And THAT one-third of the time be given over to the Ontario Municipal Electrical Association.—*Carried.*

There being no further business the meeting adjourned at 4.00 p.m.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

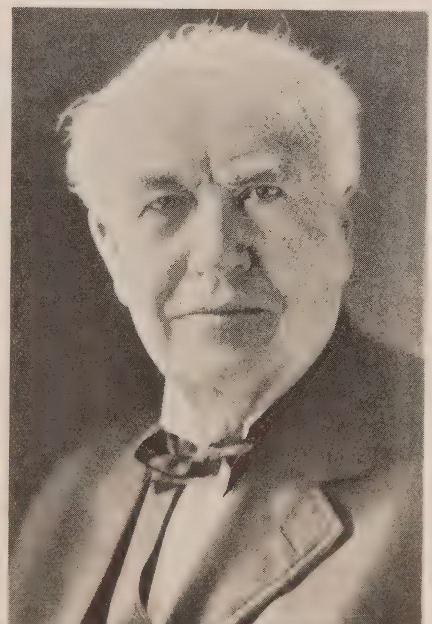
190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Thomas A. Edison

AT his home in Llewellyn Park, West Orange, N.J., in the early hours of the morning of October 18th, Thomas A. Edison died at the age of eighty-four years. In his passing there has been removed one who in a lifetime has probably accomplished more than any other on this continent for the general benefit of humanity.

The late Thomas A. Edison's ancestors emigrated from Holland to America about the year 1730. After the American Revolution the Edison family came to Canada and settled at Vienna near Tillsonburg, where his father married Nancy Elliott, a school teacher. They moved to Milan, Ohio, following the rebellion of 1837, and there Thomas A. Edison was born on February 11th, 1847.



Thomas Alva Edison
1847—1931

Space does not permit our tracing Mr. Edison's life and referring to all of his many accomplishments. At the age of twelve years he became a newsboy on trains, and worked up to the position of telegraph operator and was located at Stratford Junction, Ontario. He then began to put his mind to the improvement of the telegraph equipment used and the development of more satisfactory apparatus for the work. What was always in Mr. Edison's mind was to produce something which would be

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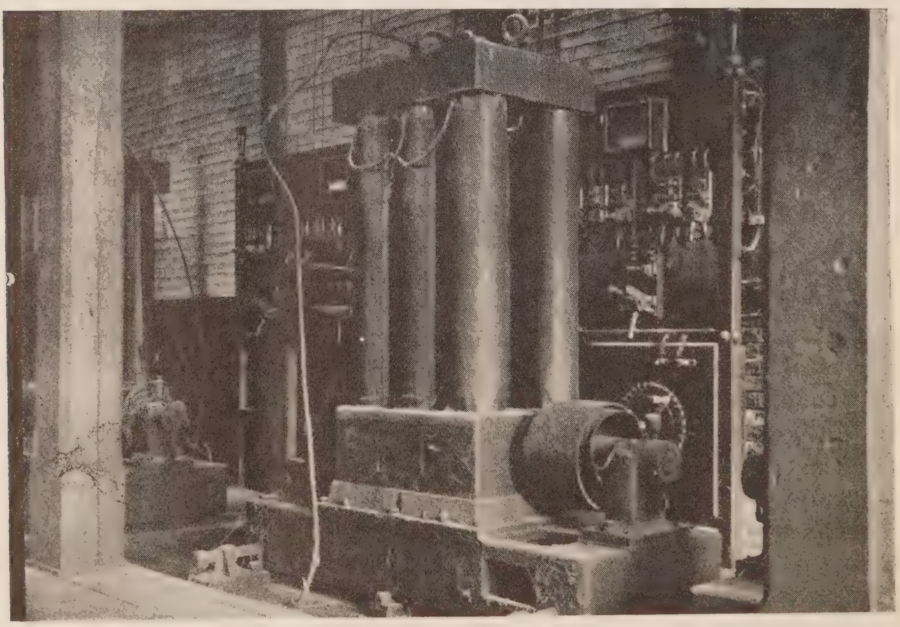
useful and which would be acceptable in the field where it was intended. This principle was impressed upon him after having completed an electrical vote-recording machine. This device was rejected for the simple reason that it would do what was required of it and thereby prevented filibustering.

It is owing to his work on incandescent electric lighting that the electrical industry on this continent must give Mr. Edison special recognition. Although experiments and developments were made in Europe about the same time as Mr. Edison's early work along this line, yet, on account of our peculiar location Mr. Edison's work had the greater bearing upon the industry in Canada.

Prior to 1880 commercial electric lighting was obtained only by the use of electric arcs. Not only did Mr. Edison produce an incandescent lamp for use in general lighting but also a complete system of power generation, distribution, control and metering and proceeded to manufacture and market complete systems. One of the first of these complete installations was installed personally by Mr. Edison in the cotton mills at Cornwall, Ontario. In this way Mr.



Edison Generator Installed in 1883 at Cornwall, Ont.

Edison performed the fundamental work, out of which our present systems of incandescent lighting have developed.

The work done by Mr. Edison in this field alone is sufficient to warrant Henry Ford, one of his greatest friends, to say—"Mr. Edison was a truly great man. He changed the face of the world in his lifetime and everything he achieved was beneficial to mankind. The epoch created by his work will influence all the future."

Presentation to A. H. McBride

The first to complete twenty-five years of continuous service with the Hydro-Electric Power Commission of Ontario

A QUARTER of a century ago, on the 16th of this month, Albert H. McBride, B.A.Sc., entered the employ of the Ontario Power Commission, which afterwards became the Hydro-Electric Power Commission of Ontario, as one of its staff of engineers. Of those of the Ontario Power Commission staff of twenty-five years ago, Mr. McBride is the only one still with the Commission. To mark this milestone, a small celebration was held on Mr. McBride's anniversary date when he was presented with an electric chime clock bearing a plaque suitably engraved and address, and a basket of roses for Mrs. McBride, as a good-will gift from his associates of the Commission. The presentation was made by Dr. F. A. Gaby, Chief Engineer, who spoke of the old days when Hydro was just beginning and of the associations that had built up with the growth of the system. There were also short addresses by some of the other older members of the staff who gave suggestions for the establishment of some system of recognition for time of service with the Commission.

The address which carried the personal signatures of everyone associated with the presentation read as follows:

"On October 16th, 1931, you will have the honour of completing twenty-five years continuous service with the Hydro-Electric Power Commission of Ontario, being one of the first Engineers engaged in the work of the Commission and the oldest existing employee in years of service.

"We, the undersigned, who have worked with you during the greater part of this time, deem it a privilege to express our appreciation of the friendship, good-will and co-operation which you have always shown to those associated with you in our work, and hope that we may continue to work together for many years to come with the same common interest in this great public service undertaking in which we are all so vitally interested.

As a slight token of our esteem and as something you may keep in remembrance of this occasion, we present you with this clock, which we hope you will keep and prize, not for its intrinsic value, but for the friendship which prompted the giving."

Some Interesting Aspects of the Hydro System

Including an Historical Review of its Policies and Achievements and a Consideration of the Lessons to be Learned Therefrom.

By F. A. Gaby, D.Sc., Chief Engineer.

(Address to Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Ottawa, June 26, 1931.)

PART III

CONSIDERING now the basic principle of service "at cost" in relation to past achievements, it should be emphasized that, besides being entrusted with the duty of having always available ample quantities of low-cost electrical energy to meet the expanding power needs of the citizens of the Province, the undertaking is under obligation to pursue such policies in the matter of designing and applying rate schedules as will maintain the finances in a state of unquestionable soundness and at the same time will make the electrical service available *to the consumers* at the lowest possible cost consistent with high quality.

In connection with this latter aspect of the activities of the Commission, it must be conceded that one of the major factors responsible for the outstanding achievements of the undertaking was the early decision to break away from the traditional practice of charging in accordance with 'what the traffic will bear', and to adopt as a basic principle embodied in the governing legislation the principle of service *at cost*. The founders of Ontario's "Hydro" system believed that only by a rate structure under which each type of consumer—and, as closely as practicable, each individual consumer—would be charged for service in accordance with the actual cost, could the maximum economic benefit accrue to the citizens of the Province. This belief has been confirmed and strengthened throughout in the experience of the undertaking, and at no time has its correctness been more strikingly demonstrated than during the present period of economic stress.

Among the benefits which are clearly attributable to the use of a rate structure which faithfully carries out

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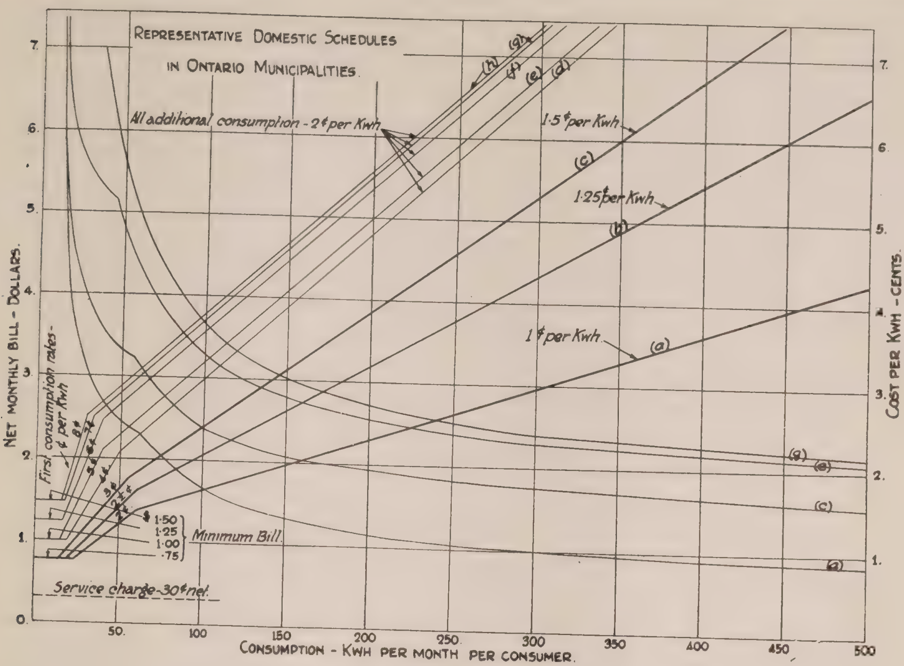
A special request has been made for the publication of Dr. Gaby's address comprehensively reviewing the work of the Commission. There is published in this issue the last of three instalments which will present the complete address.

The first instalment appeared in the August issue. It reviewed briefly the history of the undertaking with particular reference to the provision of low-cost power supplies, and showed how the history of the growth in consumption and in the supplies made available to meet demands, constitutes a criterion for the future.

The second instalment appeared in last month's issue. It summarized the basic principles that have contributed to the success of the Hydro enterprise, and reviewed the actions taken throughout the history of the undertaking to provide —by purchase of power, by construction of power plants and by the purchase of power plants—the necessary power supplies, including the steps more recently taken to provide power for the future.



the principle of service at cost, is the feature of financial stability of the undertaking. In this connection two attributes are especially to be noted.

Inducement Feature of Rate

In the first place, rate schedules for domestic service designed to apportion to each consumer the costs of the service he receives, must recognize that the additional cost to the utility of supplying a large energy consumption as compared to a small energy consumption, is relatively small, and therefore such schedules must give expression to this feature by incorporating low follow-up rates, sometimes called "Inducement" rates. The standard rates of the Commission provide for a small service charge plus a primary and secondary energy rate.

The moderate primary rate, which is also a feature of service at cost, encourages a use of the energy not only for lighting, but for those domestic appliances which give exceptional service for the amount of energy consumed. The knowledge that additional consumption will be charged for at a still lower rate, induces the consumer to extend his use of the service to the operation of larger-current-consuming appliances also. Thus the fuller utilization of service—which is to be desired both by the consumer and the utility—is automatically promoted under service "at cost" by the form of the rate schedule.

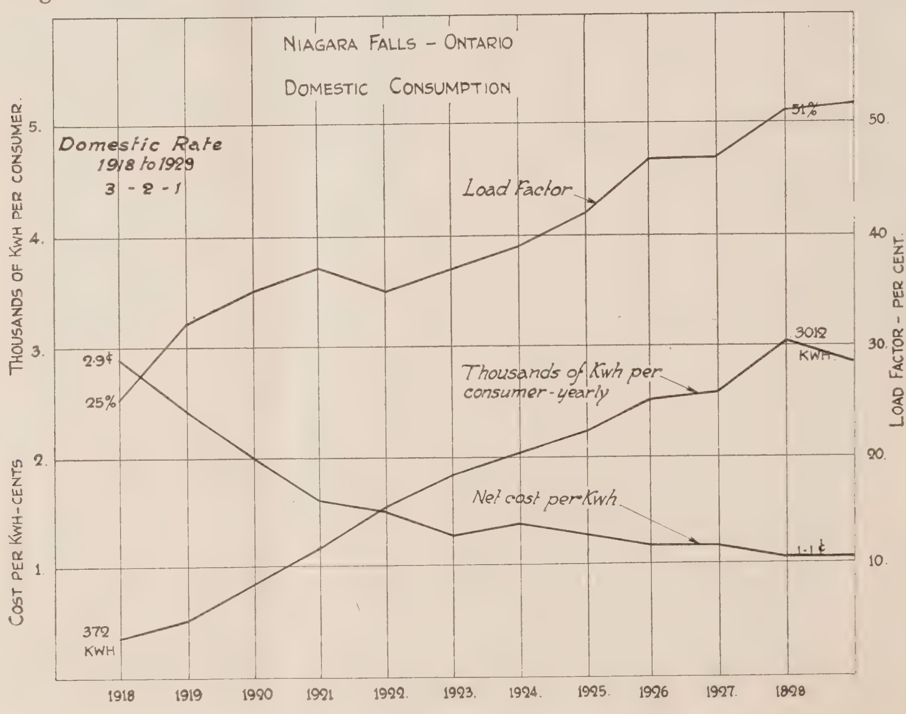
Experience demonstrates that the expansion in domestic service resulting from these features of service-at-cost rate schedules goes on in times of depression as well as in times of high industrial activity, and consequently when a recession in the use of industrial power occurs, the concurrent expansion in use of domestic service

affords an outlet for the energy that can be supplied by generating equipment which otherwise would be idle. An illustration of the advantages of this form of rate is shown in the accompanying curves relating to the operation of the electrical utility of the city of Niagara Falls.

During the period covered by these curves, from 1918 to 1929, the domestic rate schedule—being: service charge, 3 cents per month per 100 sq. ft. of floor area; consumption charges 2 cents per kw-hr. for first 3 kw-hr. per month, per 100 sq. ft. of floor area, and 1 cent per kw-hr. for all additional — remained unchanged, whereas the average actual cost per unit decreased from 2.9 cents in 1918 to 1.1 cents in 1929, with corresponding increase in load factors on the system. These curves for Niagara Falls are illustrative of the operation of Hydro domestic rates in the various municipalities.

In the second place, the policy of service "at cost" means that each class of service bears its own share of the costs of the utility, and this feature renders the financial results largely independent of fluctuations in general industrial and commercial activity. It is through a recognition of the soundness of such procedure, and a steady adherence to the principle of charging each class of consumers in accordance with the actual cost of service, that the utilities have been able to maintain an exceptional degree of stability with respect to their finances.

In 1930, for example, as compared with the preceding two years, 1929 and 1928, there has been, in consequence of the abrupt change in the industrial situation at the end of 1929, a marked



change in the relative positions of domestic service and power service, but there has been virtually no change in the financial results of operation, which have been excellent throughout the period. Revenue of the municipal utilities from power service, which had been increasing for two years by about $1,000,000 annually, in 1930 failed to register any increase. In contrast with this situation, revenue from domestic service, which in the two years, 1928 and 1929, had increased at an average rate of $840,000 per year, continued in 1930 to increase by $670,000. Notwithstanding this marked change in the relative position of the two classifications, the utilities in the aggregate were able to add to their reserves and surplus in 1930 a greater sum than the average for 1928 and 1929. It has been reported that although the demand for commercial power in the United States was reduced in 1930 by thirteen per cent., nevertheless, the domestic and light consumption increased by eight per cent.

The additional benefits accruing to the undertaking and its consumers from adherence to the principle of service at cost—including, notably, the facilities afforded for economical utilization of domestic (and industrial) equipment, the progressive lowering of the cost of service to the consumers per kilowatt-hour, and the ability to design a rate structure which can consistently be applied throughout the undertaking as a whole, giving financial results equally good in utilities where the service is predominantly residential as in those where power service provides the bulk of the business—were discussed in some detail in the Paper I presented last year before the Second World Power Conference at Berlin. To-day, I do not intend to go into these features except to comment that the favorable results reported last year have continued in the period subsequent to that covered by the data then presented. The years 1929 and 1930 have been marked by further substantial advances in the average monthly consumption of domestic consumers, by further substantial lowering of the cost per kilowatt-hour, and by a continuance of the excellent financial results.

It is important, in reviewing the past activities of the undertaking that we should not fail to recognize the vital contribution which the basic principle of *service at cost* has made to the success of the enterprise, not only by providing an element of steadiness of growth to one department which offsets unavoidable fluctuations in another department, but also by making possible a consistency of financial performance through good years and bad that could not otherwise have been achieved.

CO-OPERATION

A review of interesting aspects of the Hydro undertaking would certainly be incomplete without a consideration of that basic feature which has been so essential to success and which is summed up in the word *co-operation*. Through co-operation of many municipalities one with another in systems, it has been possible to obtain economical power supplies for all, under circumstances which would have constituted prohibitive obstacles to individual municipalities working independently of

one another. Through co-operation of all systems and municipalities working in harmony under the central administration of the Commission, the benefits of centralized engineering facilities and laboratory research; of quantity purchases of equipment and supplies; of standard rate policies and of uniform accounting have been made possible. Through co-operation between the municipally-owned undertaking and the Province the municipalities have enjoyed assurance with respect to the availability of provincial power resources for their use, and have been able to provide generating and transmitting plant at minimum costs both with respect to financing and fixed charges. At the same time the Province, through the Commission, has had the co-operation of the municipalities in the scrupulous observance of their obligations, and has in turn reaped its share of the benefits of co-operation through the general enhancement of the economic welfare of its citizens which has resulted from the activities of the undertaking.

All Elements of Community Co-operate

Not alone has co-operation prevailed between one municipality and another, and between Province and municipality, but also between the various economic elements of the community. Although the undertaking was initiated at the instance of manufacturers, primarily with a view to bettering the industrial opportunities in Ontario, it has consistently been recognized that the undertaking should not be employed to secure special advantages for industrial consumers through the exploitation of any other class of service. This co-operative spirit, reflected in a just apportionment of charges for service as between classes of consumers, has yielded outstanding benefits to all classes. A most important factor enabling reduction in unit costs is expansion in *quantities of service* supplied, and it is to be noted that, rapid as has been the growth in industrial utilization of power in Ontario municipalities, the sales and revenues for domestic and commercial services have expanded at an even more rapid rate. Under service "at cost" as applied in Ontario, economies due to general expansion, reduce the costs to all classes of service.

Rural Electrical Service

Again, by co-operation between urban citizens, rural citizens, the Province and the Commission, notable benefits have been secured for all. Had not the network of transmission lines established by the urban municipalities been available, it would have been impossible to carry out any comprehensive scheme of rural electrification. But for the co-operation of the Province in affording through legislative enactment a means of efficient organization of rural municipalities into rural power districts, one of the outstanding elements contributing to the success achieved in this field would have been lacking; and but for the financial assistance extended by the Province in pursuance of its established policy of aiding agriculture in various ways, it would not have been economically possible—as is now done—to extend Hydro-Electric service in several of the less densely populated districts.

With respect to the *direct* benefit in

load accruing to the urban municipalities through rural electrification, the effect is small on the whole, since in point of power utilization, all the rural power districts combined are approximately the equivalent of but the addition of a single urban partner of the magnitude of, say, the city of London. There is, however, a broad community of interest between urban dwellers and agriculturalists, and any improvement effected in the status of agriculture is powerfully reflected in the urban municipalities, whose citizens depend largely upon the rural areas as a source of raw materials and as an important market for finished products.

Early Legislation

Historically, although the Commission had been studying the problem of rural power supply for many years—and its first rural lines were built in 1912—it was not until the introduction of amended legislation in 1920, providing for the formation of rural power districts, that the basis was laid for the present era of expansion in rural electrification. This legislation marked the inauguration of the present system, under which each rural power district comprises the area that can economically be served from a point of supply, with uniform rates applicable to all consumers in each class throughout the district, and the Commission, on behalf of the respective co-operating rural municipalities, conducts operation of all the districts.

In 1921, provincial legislation was enacted, authorizing the payment of "grants-in-aid" up to 50 per cent. of their capital cost, in respect of rural *primary* lines on highways throughout the Province; in 1924, the grants were further extended, so that, at the present time, the Province pays 50 per cent. of the capital cost of both primary *and secondary* rural transmission lines *and equipment*, from the point of supply within the rural power district, up to the boundary of the rural consumers' property.

Rural Power Districts Pay Full Cost of Power

It should be noted that, with respect to their status as partners in the co-operative undertaking of the municipalities for the generation and transmission of bulk supplies of power, there is no differentiation between rural municipalities and urban municipalities. The rural power districts carry their full share of the costs of the collective undertaking, imposing no burden upon the urban municipalities and receiving, in respect of wholesale costs of power taken from the systems of the Commission, no aid from the Province. The "grants-in-aid" of agriculture are restricted to the *distribution* phase of activities within the rural power districts, and even with respect to distribution, the "grants-in-aid" apply only to capital cost.

Progress up to 1929

Under these provisions for co-operation between the Province and the agricultural communities, and between individual rural municipalities acting through the Commission in the rural power districts, notable strides were made in rural electrification subsequent to 1921, and more especially since 1924. Concurrently, the development and standardization of highly economical methods of rural line construction and operation by the

Commission, have substantially reduced the cost of supplying rural service.

At the end of 1921, 600 miles of rural line had been approved for the rural power districts; at the end of 1924, the mileage had grown to more than 1,200 miles, and at the end of 1929, the mileage exceeded 5,200. Similarly, the amount of power taken by the rural power districts grew from less than 1,000 horsepower in 1922, to nearly 6,000 horsepower in 1924 and to more than 22,000 horsepower in September, 1929. The number of consumers in the rural power districts also increased from 55 in 1921,* to nearly 15,000 in 1924 and over 37,000 in 1929.

Legislation of 1930

Rapid as had been this expansion up to 1929, there yet remained two directions in which by further facilities for co-operation, hindrances to a fuller utilization of the service by rural dwellers could be removed, and in 1930 the Provincial Legislature passed the enactments required for such co-operation.

Rural Loans

Prior to the coming into effect of these measures there had been farmers and others in the rural power districts who desired to take full advantage of hydro-electric service, but who were deterred from doing so by the difficulty of financing the cost of the necessary wiring and equipment on their premises. The Commission in its capacity of trustee for the municipalities had no authority or resources by which to remedy this situation. By the Rural Power District Loans Act, 1930, Provincial funds up to a maximum of $2,000,000 were made available to the Commission, and authority given to it to make loans to rural consumers, not exceeding $1,000 for any one consumer, in cases where the consumer was willing to co-operate by furnishing adequate security for such loans.

Loans may be made in respect of wiring on the consumer's premises and in his buildings, and also in respect of transformers, motors and appliances for the utilization of electric service, under regulations which provide for repayment with interest at six per cent., over various periods depending upon the character of the equipment, but not in any case exceeding twenty years.

Up to the present time sixty loans have been requested by various rural consumers, of which thirty-two have been approved, and a total of $10,887 has been loaned to farmers under the provisions of this legislation.

Maximum Service Charges Lowered

A second retarding feature had been found in the fact that in many newly-established rural power districts, a proportion of the inhabitants defer their use of hydro-electric service until the favorable experience of their immediate neighbors has convinced them that they cannot longer afford to be without the service. This condition had made it necessary at the commencement of service in a rural power district to employ relatively high service charges, which

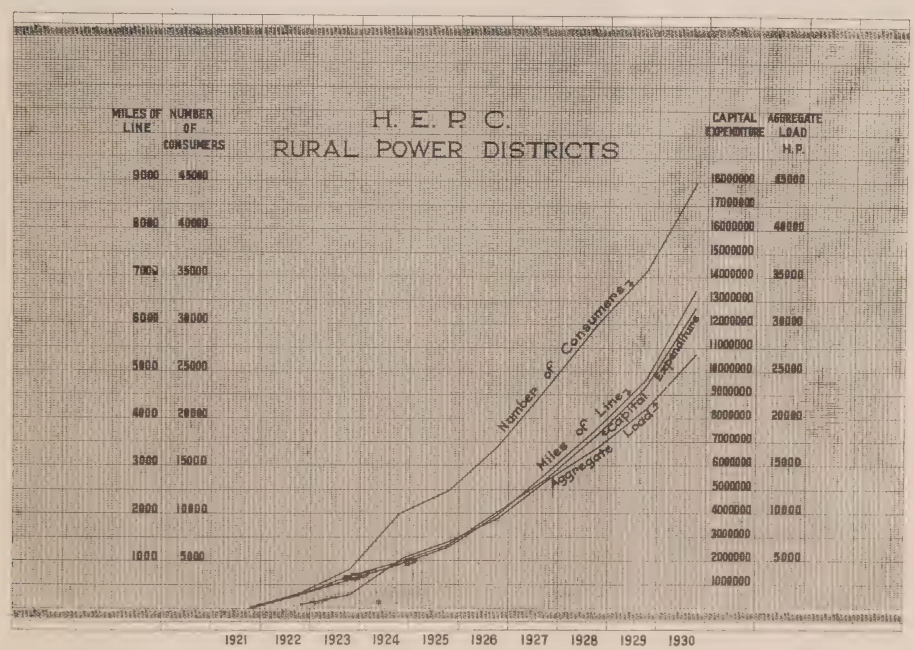
*Prior to 1921, and before the creation of rural power districts, service was given to rural consumers through certain individual municipal utilities. The rural consumers thus served, who numbered about 2,200 in 1920, were gradually absorbed into the rural power districts.

were progressively reduced as the number of consumers increased. As a result, the more progressive consumers who had supported the undertaking from the commencement were placed under rather an unfair handicap. Also, the use of the higher service charges at the inauguration of service in itself tended to reduce the number of consumers initially taking the service.

By the enactment of the Rural Power District Service Charge Act, 1930, the Lieutenant-Governor-in-Council was empowered on recommendation of the Commission to fix maximum service charges for the respective class of rural service, and any deficit resulting in a rural power district from these service charges was made chargeable to the Province until such time as it can be repaid out of surplus arising when the rural power district concerned has become well-established. The effect of this measure is to enable rural service to be supplied, even in the initial years of operation of a rural power district, with service charges which nowhere in the Province exceed for "Class 3" service the sum of $2.50 per month net, and with correspondingly moderate charges for the consumers of other classifications.

Accelerated Progress in 1930

In 1930, under these additional encouragements, electrical service was given to 9,375 new rural consumers, requiring the construction of some 1,860 miles of primary rural transmission lines, and involving a capital investment of $3,340,000 with a total to date of $12,665,000. Power supplied to rural power districts in August, 1930, aggregated nearly 29,000 horsepower, showing an increase over the corresponding month



in 1929 of about 6,700 horsepower, or 30 per cent.

The farmers of Ontario are realizing more and more that the use of efficient electrical service at low cost, such as is supplied by the Commission, helps to make agriculture more profitable. Moreover, few other agencies can contribute so much to the maintenance of a standard of living which makes life in rural districts more attractive. Not only farmers, but also rural churches, schools, stores and factories utilizing agricultural products as their raw materials, benefit from the availability of rural electrical service, and practically all elements of the rural communities are taking advantage of the service as fast as lines can be built to supply them. For the present fiscal year, arrangements are being made to construct about 1,800 miles of additional rural lines, and it is anticipated that progress in the future will continue at the present rapid pace, making a continually widening contribution to the maintenance of a well-balanced economic structure for the Province as a whole.

The Commission's Annual Report

Before closing, I should like to refer to the Commission's Annual Report. This, as you know, is a large volume running from 450 to 500 pages. It is a more comprehensive compilation than is issued, it is believed, by any public utility, whether publicly or privately owned. Facts regarding the costs and general status of the Commission's various systems and operations are carefully presented, and before each important Section in the Report will be found explanatory and cautionary comments designed to aid even the general reader in the intelligent selection and use of the data presented.

It is my conviction that if more extensive use be made in the various municipalities of the data in this Annual Report by the members of our local utility commissions and other municipal officers, it will become increasingly difficult for such misrepresentations to be made in the future as have been made in the past by those who have endeavored to cast discredit upon the efforts of the co-operating municipalities to supply themselves with low-cost power.

May I illustrate: In a recent public address delivered at Milton, Mr. Mitchell F. Hepburn is reported to have stated:

> "Under the political ownership scheme, the Chippawa development was started with an original estimate of $10,000,000, but with a final cost of $150,000,000."

Referring to this Statement, the Toronto *Star* in an editorial on May 26th says:

> "Mr. Hepburn states that the Chippawa development was estimated, in the first place, to cost 10 million dollars and that its actual cost was 150 million. He does not add that the development was enlarged to produce five times as much power as the original plans called for. The final cost was 76 millions, not 150 millions. Even that figure was excessive, but most of the excess is not fairly chargeable to 'political ownership', but to the effect of the war upon construction costs."

Those of you who were identified

with the Hydro undertaking during the period that the Queenston-Chippawa development was being planned and constructed know that Mr. Hepburn's statement is seriously misleading, and that even the statement of the *Star* gives an inadequate understanding of the fact. Of course, the figure of $150,000,000 given by Mr. Hepburn as the final cost of the development is incorrect, the actual cost—ascertainable by anyone who consults the Commission's Annual Report—was $76,000,000. This does not include the tenth unit, which was installed to provide for better and more continued service and such economies as would result therefrom. Apart from this gross exaggeration by Mr. Hepburn, however, the original estimate and the final cost relate to radically different entities. The $10,000,000—or more accurately, $10,500,000—was an estimate made in 1914-15 of how much it would cost for a plant with capacity of 100,000 horsepower, at the rates of wages and prices of construction materials prevailing at that time. Thus the original estimated cost was $105 per horsepower in terms of 1914-15 dollars.

The $76,000,000 — incorrectly stated by Mr. Hepburn as $150,000,000–was the actual expenditure on the development finally authorized, with capacity of 550,000 horsepower, and with the bulk of expenditure made when, owing to war-time inflation the dollar had become a monetary unit of radically changed purchasing power, resulting in increase of wage rates by over 125 per cent. and of unit costs of construction materials by at least 100 per cent. Thus the final cost was $138 per horsepower in terms of 1918-1921 dollars, equivalent to less than $70 per horsepower in terms of the 1914-15 dollars of the original estimate.

In view of these facts, how unreasonable—not to use a stronger term—it is to make an unqualified statement representing that under what is so incorrectly termed "the political ownership scheme", the final cost was 15 times greater than the original estimate. Actually, far from being excessive, the final cost per horsepower was, in terms of dollars of constant purchasing power, one-third less than the original estimate.

It can only be concluded that Mr. Hepburn, through failure to obtain his data from reliable sources, namely, such as the Commission's Report, has done the work of the municipalities a serious injustice by representing that certain properties which have cost but $76,000,000, had actually cost $150,000,000. The difficulty has been that instead of going to the Commission's Annual Reports, Mr. Hepburn has employed figures which are presented in a recent attack upon the Hydro-Electric Power Commission published in the United States, in the preface of which foreign publication it is stated for the information of the subscribers to the publication, that the data supplied by the publication—I shall quote the exact words —"will fit in with any publicity policy which you adopt or have in practice. In case of a thorough-going anti-municipal ownership advertising campaign you will find this information indispensable."

Furthermore, the subscribers are informed that the reports "contain certain excellent material for evidence

EXTENT OF OPERATIONS AND RECENT PROGRESS

	1912	1924	1930
Number of Municipalities served—			
Cities	11	25	27
Towns	14	82	92
Villages	6	102	118
Police Villages*	2	78	137
Townships*	...	131	311
TOTAL	33	418	685
Miles of primary transmission lines constructed—			
High-tension lines (12 to 220 kv.)	280	3,616	4,636
Low-tension lines†	344	548	626
Rural low-tension lines (4 and 8 kv.)	...	909	6,796
TOTAL	624	5,073	12,058
Growth of load	h.p.	h.p.	h.p.
Total available capacity including power contracted for	100,000	864,690	1,497,567
December peak load distributed	21,155	780,789	1,286,278
Number of consumers served—			
Domestic service	28,230	332,999	448,283
Commercial light service	8,862	57,272	76,694
Power service	1,621	10,744	13,431
Rural power districts	....	14,907	47,859
TOTAL	38,713	415,922	586,267
Revenues—			
Combined revenue of Commission and municipal electric utilities	$1,617,673.53	$24,855,056.01	$41,620,815.64
Reserves—			
Of Commission for sinking fund, renewals, contingencies and insurance	....	$13,440,810.50	$54,935,012.74
Of municipal electric utilities	....	24,267,977.17	48,912,833.47
TOTAL Reserves	....	$37,708,787.67	$103,847,846.21
Capital Investments—			
Investments of Commission	$4,109,000.00	$190,027,909.00	$260,583,838.00
Assets of Municipalities (exclusive of sinking fund equity in H.E.P.C. System) in "Hydro" undertaking	6,347,000.00	67,333,029.00	99,054,262.00
TOTAL Capital Investment	$10,456,000.00	$257,360,938.00	$359,638,100.00
Sinking Fund equity of Municipalities		$5,420,567.00	$17,346,372.00

*Most of the townships and smaller police villages are served as parts of rural power districts.

†Exclusive of local distribution.

and exhibits," and also are of service to be generally used in connection with "all cases before civic organizations, city councils, state commissions and courts". This, then, is the publication which contains the erroneous data, including the statement regarding the cost of the Queenston-Chippawa plant, which Mr. Hepburn has used for purpose of "evidence and exhibits." It is much better to appeal to the Commission's carefully-prepared and audited Annual Reports.

If Mr. Hepburn had consulted the Commission's Annual Reports when he was preparing his address, he would have perceived that many of the other statistics and statements he quoted from the United States publication were without foundation, and intended to represent the reverse of the facts. Mr. Hepburn, for example, quoted comparisons of revenue per kilowatt-hour, and drew conclusions respecting rates from such data that were entirely unjustified. In the Annual Report the serious fallacy involved in the use of revenues per kilowatt-hour as a criterion of rates for comparative purposes is fully explained. Also, if he had consulted the Annual Reports he would have known that the data he quoted for the Ontario Hydro in 1925 were incorrect, Quebec figures being in some cases confused with Ontario figures, and others of the statistics involving a large amount of duplication.

So long as the Ontario Hydro-Electric undertaking continues to be the outstanding example of successful public ownership of electrical utilities that it has been in the past, it is to be expected that efforts will be made to discount its achievements. For the most part these efforts can be relied upon to defeat themselves, because their authors must resort to such expedients as misstatement of fact and misleading presentation of data, the true character of which can easily be seen by reference to official sources such as the Commission's Annual Reports.

The extent of the Commission's operations and relative progress from 1924-1925 to 1930 shows a remarkable growth of the Commission during these periods, not only in the number of its consumers and the quantity of power delivered, but in the strength of its financial position and the magnitude of its reserves.

Our review of the activities of the Hydro-Electric Power Commission of Ontario and the associated electric utilities has, I trust, enabled us satisfactorily to trace the evolution of the undertaking to its present imposing status. Supplementary enactments have, from time to time, been passed by the Ontario Government and have contributed greatly to the extension of electrical service throughout the Province. The basic principles as first inaugurated have stood the test.

As Sir Adam Beck more than once specially stated in his later years, so long as the spirit of helpful co-operation and mutual confidence characterizes the relationships of the municipalities themselves and exists between them and the Commission, there is no reason why the progress which has characterized the Hydro undertaking in the past shall not be maintained throughout the days which are to come.

Cavitation of Large Turbine Runners

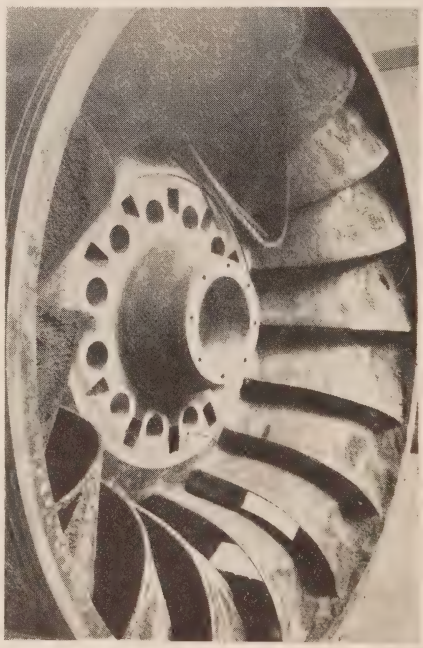
By A. S. Robertson, Operating Superintendent, Queenston Generating Station, H.E.P.C. of Ont.

(From a paper read before Toronto Section A.I.E.E.)

CAVITATION, or commonly known as pitting, is one of the more serious and troublesome problems met in the operation and maintenance of turbine runners. Cavitation may be briefly described as the appearance on certain surfaces of the turbine runner of a honeycomb-like surface, which, when once started is accumulative due to the roughing of the original surface, and extends both in area and in depth. If such a condition is permitted to continue without treatment it will finally develop into large holes and destroy the usefulness of the runner.

The cause of cavitation has been the subject of much study and research for some years. There seems to be two main theories advanced as to its cause: (1) chemical action, and (2) mechanical action. The first, chemical action, is based on the theory that air freed from the water due to sudden changes in pressure when passing through the turbine sets free the excess oxygen dissolved in the water at its higher pressure. The freed oxygen being in a nascent state oxidizes the metal surface in this low pressure area. The second theory is that vortices are formed on the surfaces in question, due to improper stream lines, which cause the water to leave the metal surface; these vortices in collapsing produce very high impacts on the metal surface which occurring in rapid succession produce the cavitation. From extensive tests and investigation extending over several years, the British Admiralty, in a published treatise on cavitation of ship propellers, shows that impacts may occur in excess of 700 tons per sq. inch on the collapse of these vortices. They found that these impacts may not only cause cavitation on the surface of the propeller blades but actually bend them near the tips.

To us it seems reasonable to believe that both of the conditions may exist, that is, a combined action of the mechanical and chemical theories.



Cavitation on 52,000 h.p. turbine runner after 4.5 years' operation

Close-up of 52,000 h.p. turbine runner showing cavitation

Our experience has demonstrated that cavitation may be arrested to some extent by using a runner made entirely of non-corrosive material, or by welding the surface with non-corrosive metal. This may be done by only treating that part of the surface which is subject to excess cavitation or treating the entire surface of the runner. At the same time we know that runners made entirely of non-corrosive material have pitted to some extent, although they usually present a somewhat different appearance; their appearance being such as suggest the cause as being entirely mechanical thus bearing out the theory of collapsing vortices.

Operating Conditions Affect Cavitation

The operating conditions under which the runner may have to operate also cause cavitation; such as prolonged operation at very light or very heavy loads, or high wheel setting with, in consequence, high draft tube vacuum and the head under which the runner operates. Also, it must not be overlooked that the designer of the runner has the primary and major control of extent to which a runner may be affected by cavitation.

The electric welding machine is the principal device used for repairing runners. It is particularly fitted for this job due to the fact that the sections to be repaired do not require any preheating; it lends itself readily to overhead work and to closely confined spaces. In consequence of these properties the electric machine is used entirely by the Hydro-Electric Power Commission of Ontario for runner repairs.

The welding on turbine runners is to us a problem of considerable interest with a wide open field for further research.

The requirements of a weld on a turbine differ from those in general welding work where the strength of the weld is of first importance, In welding runners the strength is still of importance, but in addition the weld must possess other properties.

If the surface is to be machined, a welding rod must be selected to permit machining. In addition and of great importance, the metal in this welded surface must resist cavitation to the greatest possible extent. The importance of this will be better realized when it is stated that by proper selection of metals for welding it is possible to not only equal but increase the resistance of the new

surface over that of the original surface.

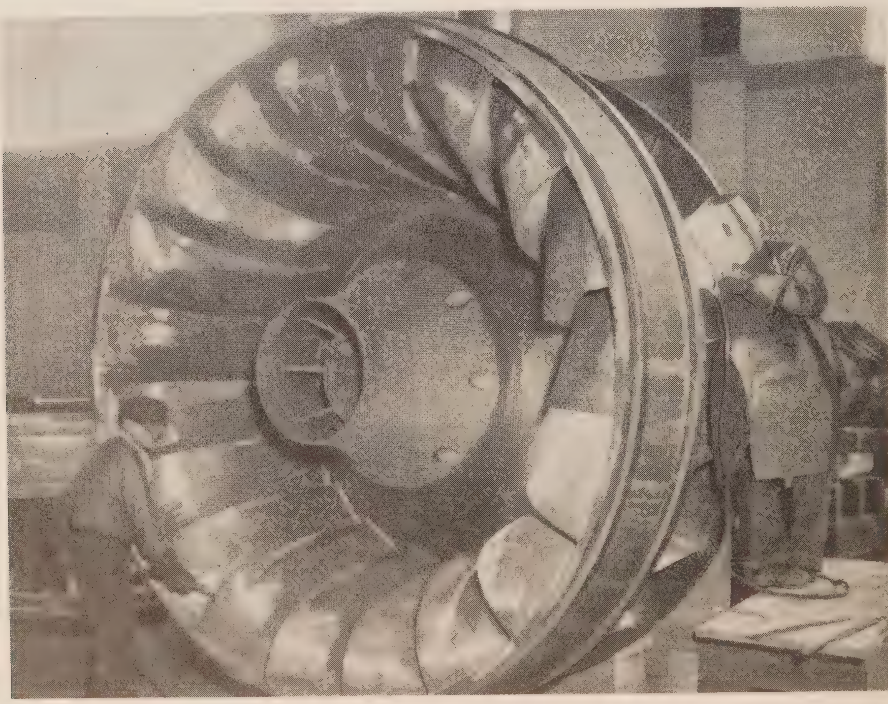
The coating on the rod is the principal difference between various manufacturers' products; it is not difficult to obtain rods of the same analysis from various manufacturers but what the analysis of the weld will be, depends to a large extent, on the coating. The coating is used as a flux to prevent oxidization while the metal is being melted and presents some real problems, especially in some of the stainless steels.

Absolutely Clean Surface Necessary

The area to be welded is first chipped with a chipping hammer to remove all the pitted metal. It is very essential that the surface be thoroughly cleaned before starting to weld, as the bond and penetration of the new metal depends entirely on a clean surface. If the bond is not good, pitting is liable to completely undermine the welded surface.

The chipped area is then built up, layer by layer, until the cavity is filled. In dealing with deeply pitted areas we find it expedient to deposit the underlying area with a soft iron rod, as this allows more satisfactory peening. On the surface areas we use a flux coated steel rod of 60,000 lb. to the square inch tensile strength.

An experienced runner welder usually can improve the operation of the runner by removing any of the original high spots on the buckets, by observing the contour of the least pitted bucket and building the other



Rebuilding a 58,000 h.p. turbine runner by electric welding.

buckets to this contour, also by observing the location and nature of the pitting on each bucket and making the corrections which experience has shown are of value. The changes are of course small but nevertheless marked improvements may result from such small changes.

Stainless Steel Experiments

In addition to this method we are at present experimenting with a final surface of one and two layers of stainless steel. While it is too early to make any positive statements, we know that a particularly rapid pitting runner which was partially treated with a stainless steel weld, after four months' service is showing very encouraging results. The stainless steel areas still bear the grinding wheel marks while the untreated areas have already started pitting.

This is especially encouraging to us from the fact that the areas covered with stainless steel are those which were subject to rapid and excessive pitting which usually developed in two years into large holes. These areas are in perfect condition, while, in spite of the fact that the untreated areas were in the slow and only lightly attacked areas, they are showing pitting in some cases to a depth of ½ inch.

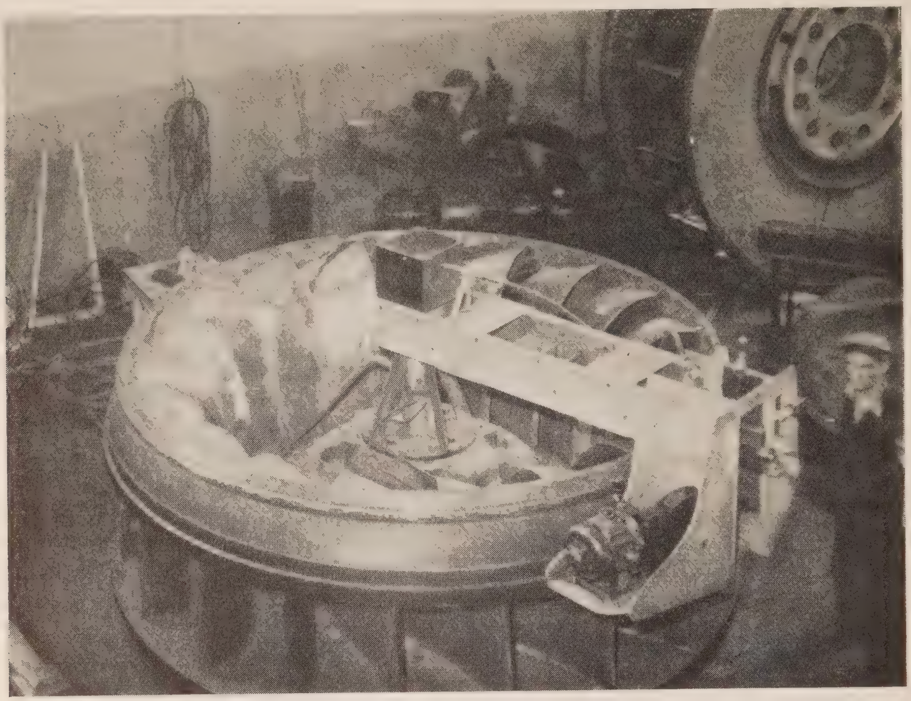
As each layer is laid by the welder it is thoroughly peened with an air hammer and a peening tool. This is partly to work out the shrinkage stresses in the weld and preventing pulling or warping. The peening also produces a more even surface for subsequent layers, breaks up the slag and oxidized coating of the weld thus giving a much sounder and homogeneous surface on which to build the succeeding layers.

"Side" Method Adopted

In rebuilding runners removed from the units, we have also adopted, where possible, the method of making all welds "side" welds instead of welding on a horizontal surface. In flat welding there is a tendency for the welder to just melt and drop the metal which sticks because the surface is flat. Such a weld has not a proper penetration or bond and results in poor anti-cavitation properties. If the welder uses the "side" method, any attempt to such dropping of the metal will result in the metal rolling off the inclined surface. Thus this method automatically checks up on poor welding methods.

After the final layer has been deposited and peened, the weld is very carefully ground to a smooth contour with a portable air grinder. The grinding, in our opinion, is of as great importance as the welding and unless properly done may cause trouble. To do this job properly requires skill on the part of the operator and a proper assortment of grinding wheels to meet all the varying shaped areas of a runner bucket. When the grinding is finished the welded area should present the proper contour. If rough, or high or low spots are left, it will cause pitting either in an entirely new place or aggravate the pitting of the original area. It also may cause a more serious condition by shifting the pitting area to a portion of the runner where it cannot readily be welded or ground due to lack of working space.

If the stainless steel will stand up under these conditions, its general use



Power driven grinder for grinding runner seals after rebuilding by electric welding.

will be justified. It also may lead to the coating over of the entire surface of a new runner before putting the runner in service which would enable the runner to be made as an ordinary steel casting and the more expensive metal covering put on as a thin coating.

In general, our experience in welding indicates that a properly welded runner will offer greater resistance to pitting than the original surface. There seems to be two reasons for this: first, a properly made weld of good material, well peened and carefully ground, seems to be more anti-corrosive; and second, the nature of the original pitting often suggests changes in the contour of the blade or other parts of the runner, such as increasing the thickness of the pitted portion and streamlining the other portion about this area.

Seven Years Operation

While in general the welded surface will give longer service than the original metal, this is not always the case as we have had welded surfaces last no longer than the original metal, while others have given three times the original life. By doing a certain amount of annual welding in place, that is, without dismantling the unit, on areas that can be readily repaired, our runners will in general, operate for about seven years. After this, it is necessary to dismantle the unit and remove the runner for a general welding overhaul.

When a runner has been removed from service it is gone over very carefully and thoroughly, the welding and grinding is finished with great care, greater than can be done in place due to awkward location of work; the seal rings are re-built by welding and ground to size by a special grinding machine. It goes back into service as a new runner and starts out on a new seven year cycle. How long this can be kept up remains to be proved, as we are only on our second cycle. However, we believe that the application of stainless steel to these inaccessible places will materially increase the length of the cycle.

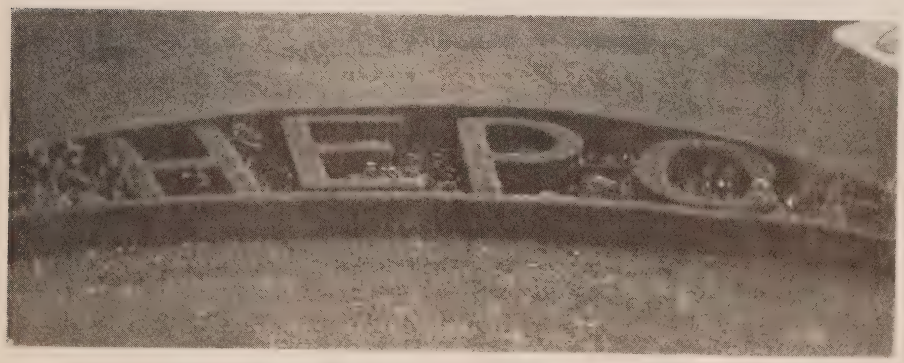
It costs about \$200 per year to maintain a runner in place and \$2000 for a rebuild, so that our total cost per year for runner upkeep is $1/7 \times (\$200 \times 6 + \$2000 =) \$457.14$ per runner per year, exclusive of dismantling charges.

Elephant's Excessive Curiosity

An unusual example of technical curiosity on the part of a passenger—curiosity which nearly resulted in tragic consequences—is reported from the Great Indian Peninsula Railway.

It appears that the owner of an elephant had occasion to transport his charge from Poona to Bombay upon this Railway, which has recently been electrified by British Insulated Cables, Ltd. Unfortunately, the animal was loaded into an open truck and his interest in and admiration for the overhead fittings, which were alive at 3,000 volts, proved too much for his discretion; his trunk wandered, investigating . . . and when he had sufficiently recovered he was taken out of the truck and proceeded to Bombay by the old-fashioned method of walking the whole 111 miles.

—*Electrician.*



Flower bed in grounds of London Transformer Station of the Hydro-Electric Power Commission of Ontario.

Radio Interference

IV

Power Line Interference

RADIO Interference from power lines may be experienced in the neighbourhood of such lines when alive, or from other lines passing near to live lines. This interference may be very serious over a certain area, along the line, though it is not as far reaching as some other types, such as heterodyne interference or atmospherics.

Interference from a power line may be from any or all of three sources:—

(a) Induction from the low frequency fields in the neighbourhood of the power conductors.

(b) Leakage from within, or over the surface of insulators.

(c) Corona.

(a) The first source of interference is an inherent feature of any power line along which power is being transmitted; an electrostatic field exists, due to voltage on the line and a magnetic field is also present when current is flowing in the conductors.

The electrostatic field will exist alone when the line is on potential but without current flowing. As it is this field which affects the usual type of radio receiving station with the ordinary capacity type of aerial,—*i.e.*, one or more elevated wires running in any direction,—the strength of interference from a power line may not vary appreciably with the loading of the line. A suitable drain coil from aerial to ground may be all that is necessary to prevent interference from the electrostatic field in the neighbourhood of a power line.

The magnetic field will be likely to affect receivers using loop aerials in very close proximity of the power lines. It is doubtful whether any type of by-pass, condenser, or drain coil, would be satisfactory for such installations. The magnetic field, however, may not cause interference to any appreciable distance from the line, not even as far as the limited electrostatic field.

(b) Leakage from the line to isolated metal parts, or over the surface of insulators, may produce a type of interference which will travel along the power conductor and radiate to distances of several hundred yards from the lines. This type of interference is usually very persistent and is particularly serious due to breadth of tuning,—*i.e.*, not being confined to any definite points or part of the receiver dials.

The locating of the cause of interference from a power line is usually more difficult than tracing down an offending appliance. This is particularly the case where the interference is due to discharges over insulator surfaces, as then there are likely to be several similar sources, or several hundred sources producing the same type of interference simultaneously at as many different points along the lines.

(c) Interference may be caused by corona but it is not usually serious as the majority of lines have conductors of sufficient size to prevent corona formation at normal line voltages.

Sharp points or edges may cause concentration of stress, however, and result in discharges which may cause slight interference, but the sound of interference due to corona is such that it is not very objectionable.

Power line interference caused by leakages or discharges, (*b*) may be segregated, very definitely, into two groups.

1. Interference caused by discharges to isolated metal parts, such as tie wires loose on conductors or separated by corrosion, dirt, etc., also by discharges through air to insulator surfaces, or within insulators.

2. Interference caused by discharges over the porcelain surfaces of insulators.

The segregation of radiated interference into these two groups provides a basis for determining the location of the source, for if it be of the former type, it is probably being caused by one or more loose tie wires, or isolated metal parts too near to the conductors, whereas if it be of the latter type, it may be due to faulty insulator design, or to overstressing of insulators due to proximity of metal standards, metal piers, or switching structures. The first type of interference may come from any insulator on the line whereas the latter would probably originate at switching points.

There are at least three methods of segregating interference into these two groups after it has passed through the radio receiver. These may be applied according to local conditions. The methods are:—

(a) Audible Tests.
(b) Oscillograph Tests.
(c) Interference Strength Measurements.

The audible tests and interference strength measurements require a certain degree of control of line voltage, whereas the oscillograph tests may be made at any fixed line voltage at which interference is found. These tests may be made in the field on power lines, or in the laboratory on individual insulators: they must be applicable to three phase lines as well as to single phase circuits.

Audible Tests

These tests are made without any special test equipment but it is necessary to be able to vary the voltage of the line or the voltage applied to one or more insulators under Laboratory test.

The voltage is gradually increased: interference commences at the critical interference voltage. If the interference be of the first type,—*i.e.*, due to discharges to isolated metal parts, —the sound of the interference will gradually rise in pitch as the voltage is increased, and vice versa. If, however, the interference be of the second type,—due to discharges over porcelain surfaces,—the interference will increase in intensity as voltage is increased but will not change noticeably in pitch.

This test is equally applicable to three phase or single phase systems and the ear can readily distinguish one type of interference from the other.

Tests have been made on single insulators at given voltages and indicate that it usually is not possible to determine line frequency correctly by the sound of the interference. The

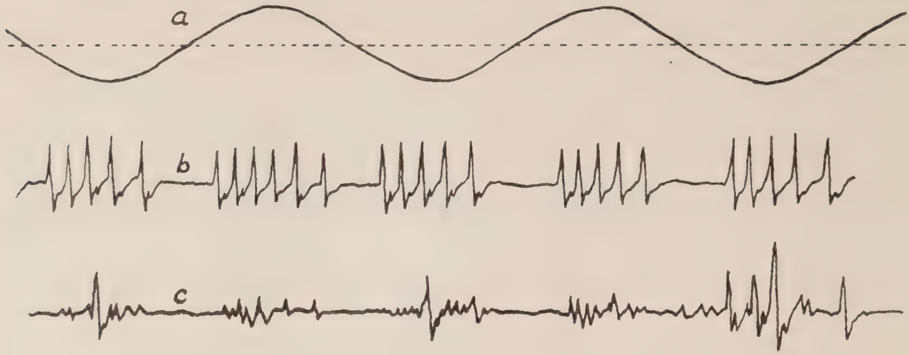


Fig. 1.—Wave Forms of Radio Interference. (*a*) *Applied Voltage.* (*60 cycles*) (*b*) *Interference caused by discharges to isolated metal parts.* (*c*) *Interference caused by discharges over porcelain surfaces.*

ear could not accurately decide, therefore, that interference is coming from a 25 cycle rather than a 60 cycle line, or vice versa. This is a very important feature: the ear may be very misleading in searching for interference in a district where power lines of both frequencies exist.

Oscillograph Tests

When the oscillograph is used on tests on a single phase circuit, the interference of either type is seen to be grouped, in two groups per cycle, each group occurring with the high voltage part of each half cycle of voltage, Fig. 1.

The oscillograms differ, however, for the two types of interference. For the first type,—discharges to isolated metal there are several successive and similar interference waves per half-cycle all equal in amplitude, Fig. 1 (*b*), the number increasing with the applied voltage, this evidently being the reason for the rise in pitch in the audible test. For the second type, namely, discharge over porcelain surfaces, there is one, or possibly there are two peaks of interference wave per half-cycle followed by a damped train of waves, Fig 1 (*c*), these peaks increasing in amplitude with the voltage but not increasing in number of waves per half cycle.

The wave forms of the two types of interference on single phase circuits are sufficiently different to be readily distinguishable. On three phase systems, however, the waves may be so intermingled as to be confused by the oscillograph test, whereas the audible test would still be able to distinguish between them.

The oscillograph tests do not require control of line voltage. The Laboratories are now equipped with a portable oscillograph which may be used in the output circuit of a special amplifier following a radio receiver, or in the output circuit of a sensitive receiver without further amplification where interference is very severe.

Interference Strength Measurements

By means of a sensitive audio frequency ammeter, placed in the output circuit of a radio receiver, direct measurements of interference strength may readily be made for different existing conditions. By recent tests

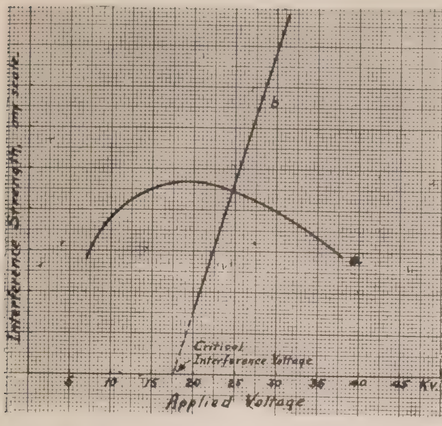


Fig. 2—Interference Strength Measurements. (a) Interference caused by discharges to isolated metal parts. (b) Interference caused by discharges over porcelain surfaces.

in the Laboratories, it has been found that the characteristic variations of interference strength with line voltage differ considerably for the two types of leakage interference. This, therefore, is a third method of analysing interference from power lines according to the segration suggested above.

For interference caused by discharge to isolated metal parts, etc., the characteristic curve of interference strength, plotted on the basis of line voltage, is a curve, approaching a semi-circle, Fig. 2 (*a*), the indicated strength commencing at the critical interference voltage, at first rising with the line voltage, becoming constant and then decreasing while line voltage is increasing and audible pitch is rising.

For interference caused by discharge *over* porcelain surfaces, the characteristic curve of interference is a straight line, commencing at the critical interference voltage and rising as voltage increases, Fig 2 (*b*).

Field tests have been made on 33 kv. lines where voltage could be controlled and showed the latter characteristic, Fig. 3 (*a*), suggesting that the interference commenced at a critical voltage of 20 kv. and was due to discharge over porcelain surfaces of insulators, occurring at nearby switching structures, and not to any arcing through air, to loose tie wires or other isolated metal parts.

This method of testing by measurement requires that control of voltage be available, but has an advantage over oscillograph tests in that it is equally applicable to three phase or single phase systems.

These recent tests in the Commission's Laboratories apparently give a new basis for consideration of interference from power lines and the full possibilities in this method of segregation are not yet apparent.

Application of Tests

With the results obtained by the

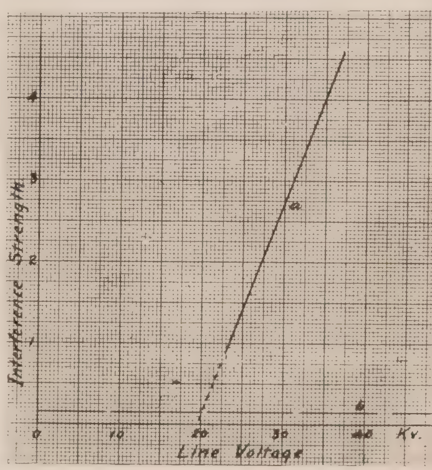


Fig. 3—Interference from 33 kv. line. (a) Interference from insulators. (b) Background Interference.

above methods it appears that radio interference, after being received from a power line, may be analyzed readily into the two groups. On systems where the line voltage may be varied, the characteristic curves may be obtained and an analysis made from these. Where the voltage cannot be varied conveniently, as on part of a large power system, a portable oscillograph would be required, Audio tests would serve as a check on the other test.

The analysis would indicate which type of interference was being received, and probably eliminate one or other type from consideration at once. If the interference were found to be of the former type, discharge to isolated metal, etc.,—it would be known that the porcelain was not overstressed and a search would be made for loose tie wires or mechanically cracked lower sections of insulators on the system; if, however, the interference were found to be of the later type,—discharge over porcelain surfaces,—search would be made for overstressed insulators on structures and the type of insulation would also be in question.

One application of the method of measuring strength of interference caused by leakage over porcelain will be the measurement of critical interference voltages of various designs of insulators. The characteristic curve for this type of interference, being a straight line, Fig. 2 (*b*), obviates the necessity of taking readings at voltages where the interference is just beginning and liable to be confused with interference from other sources. Several readings are taken at voltages where the interference is well established: these readings lie on a straight line which, when projected down to the abscissa of the graph, gives the voltage at which this type of interference commences on the insulator under test,—*i.e.*, the critical interference voltage.

The critical radio interference voltage of an insulator is a factor to be given serious consideration in the designing of all types of insulators, and, doubtless, in the near future, will be specified with other listed data pertaining to the different designs. The method of measurement outlined above and in use at the Laboratories offers a quick and reliable means of obtaining this information. The variation in interference voltages for a number of insulators of any given design also may readily be determined.

Types of Insulators

There are two main groups of power line insulators, pin type and suspension insulators. There may be interference from either type of insulator but as the latter type are usually under strain, there are not liable to be loose tie wires, or other loose metal parts: on the other hand an insufficient number of strain units, or proximity of grounded parts may produce just as much interference from the suspension as from the pin type insulator. The above tests are applicable to both types of insulators.

Attenuation of Interference

Some types of interference attenuate rapidly in travelling along power lines, whereas other types may still be very strong at a considerable distance from the source. Wherever possible,

it would be very desirable to trace down the source of interference by measurements of attenuation along the power lines.

Such tests, however, are largely field tests and can hardly be performed with success in the confined space of a laboratory. The chief problem in measurement of attenuation would probably be the maintaining of consistency of exposure, between aerial and power line at different locations along the line, to insure equal coupling at the points where interference is measured. The usual types of signal strength measuring equipment would be suitable for investigations of this nature.

Co-operation and Relief

In the recent issues, the nature of interference, its sources, location and suppression, have been discussed, but there still remains much to be said regarding co-operation towards the relief of annoying interference,—co-operation between the listener suffering this interference and the companies, or parties, who may be able to improve the conditions causing it. Some viewpoints of this phase of Radio Interference are being discussed in the next issue of the *Bulletin*.

—*F. K. D.*

Re Aluminum Paint on Poles

On page 330 of the September issue of *The Bulletin* in an article on "Precautions in Setting Poles", appears the following:

"If the pole is creosoted, first give the creosote a coat of aluminum paint and then one of color."

The use of aluminum paint has been questioned on account of its conductivity and thus causing a hazard. This matter is now being investigated and we hope very soon to have definite information on this subject. In the meantime, we would recommend that contemplated work of this nature be deferred.

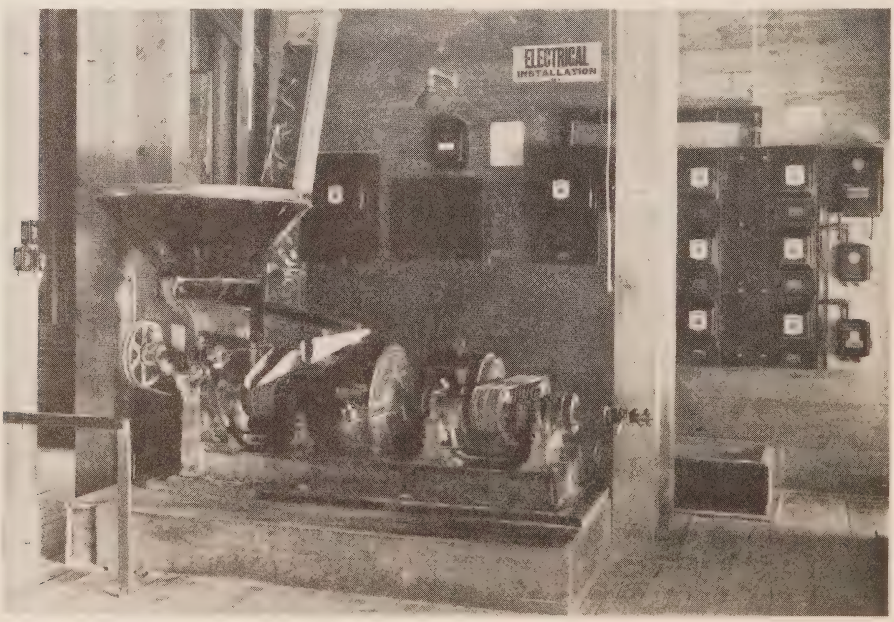
Wheatley Chopping Mill

AN example of what can be done in adapting a chopping mill to electric drive is found in Wheatley, Ontario. This mill was formerly driven by a gas engine, operating a chopper, oat roll, corn sheller, feed mixers and conveyors. The accompanying illustration shows the chopper and the electrical control.

Power is supplied to the mill at 550 volts from three 15 kv-a. 2200/550 volt, 25 cycle transformers and measured by a combined demand energy meter. Directly under the meter is a steel box housing the current transformers, the small test link panel and potential fuses. The short meter wires from this box to the meter are the only open wires in this installation. All other wiring is enclosed in conduit or flexible cable extending to condulets fitted on the motor frames.

The six switch boxes contain fuses and switches controlling six motor circuits. On the extreme right are shown three of the motor controllers. The other three controllers are at the left of the switch boxes and hidden by the conveyor housing. Three of the push buttons are shown on the post at the left of the picture. These control the two chopper motors and the conveyor motor.

The motors are all 550 volt, 3 phase, ball-bearing cross line start, with automatic push-button control. Each motor is equipped with an automatic centrifugal clutch which allows the motor to attain maximum speed before it picks up the load, thus



Chopper and electrical control layout.

eliminating heavy starting currents.

The chopper is an 18 in. double-head, ball-bearing throughout, 2,100 rev. per min. It is driven by two 15 h.p. motors, 1,440 rev. per min. with V belt drive. This permits placing the motors very close to chopper and allows the belts to be slack and yet not slip. The oat roll is operated by a 5 h.p. motor of the same type as those of the chopper, 1,440 rev. per min., with silent chain drive operating in oil. The corn-sheller is operated by a direct connected 5 h.p. motor and another 5 h.p. motor is direct-connected to the feed mixer. Both of these motors are the same as that driving the oat roll. The conveyors are operated by a 3 h.p., 1,430 rev. per min. motor, connected by silent chain drive to the conveyor shafting in the loft of the mill.

In operating the mill, care is taken to so arrange the work that the least number of motors will be running at one time. This has resulted in a monthly demand of about 35 h.p., while that of one month was 32.17 h.p.

When the mill was operated by gas engine, extra help had to be engaged to look after the starting and stopping of the engine, lacing of belts and looking after shafting and bearings. When repairs to the gas engine were required, there was an added expense as a man had to be brought in to do the job. With the electric drive, the miller, with the help of his young son, easily handles all of the operation to the satisfaction of his customers. Though it is now about a year since the change was made to electric drive, the owner has not had any expense on account of maintenance or repairs, which no doubt contributes much to his satisfaction, with results obtained.

Wheatley Hydro-Electric System may well take great pride in the completeness and efficiency of this installation, which shows systematic thought in working out all details.

O.M.E.A. — A.M.E.U. Convention at Royal York Hotel, Toronto

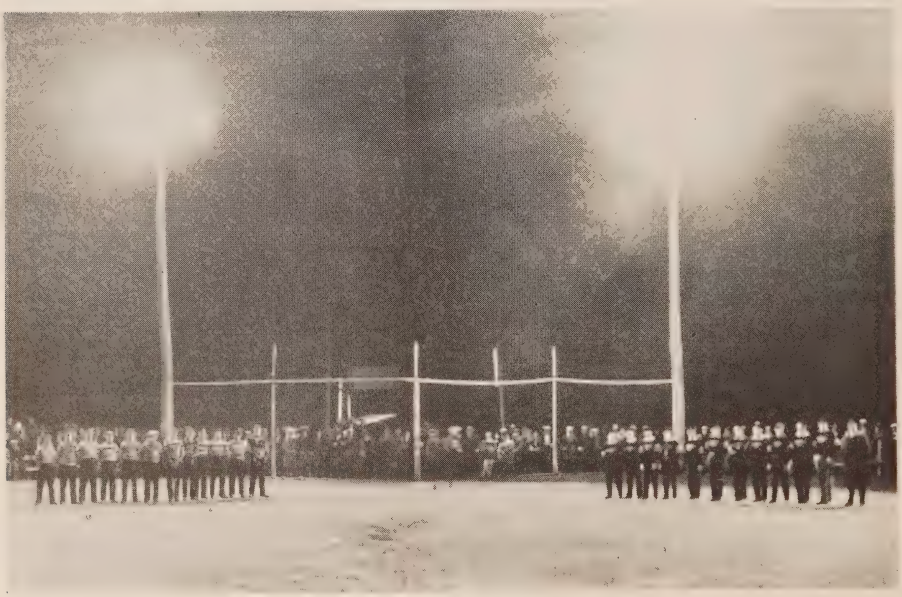
January 27 & 28, 1932

Alma Athletic Field

THE views shown herewith were taken at a rural community athletic field at Alma, a hamlet in Wellington County about five miles northwest of Elora. Floodlighting of sports fields in urban communities is becoming common, but that at Alma is the first rural field in Canada—if not on the continent—to be so lit. This was made possible by the existence of Hydro rural service, the efforts of the Alma Ball Club and Dr. G. A. McQuibban, the member of the Ontario Legislature for North-East Wellington.

The story of Alma Athletic Field had its beginning some thirty-five years ago when the proceeds from a community concert and lawn social held by the villagers was set aside as a fund for promoting sports in the district. Three Trustees were appointed to administer the fund, which was deposited with a bank. As time went on, two of the Trustees had died and the third, having become infirm, stressed the necessity of appointing a new Board of Trustees, as the fund still remained in the bank and no use had as yet been made of it. It was, therefore, placed in the care of the local school board.

About ten years ago, realizing that the fund was still in the bank, the school board decided that it be applied to the improvement of the school property. This brought forth a protest from the citizens, who considered that such action would be a breach of trust and suggested that the money be used to purchase three acres facing the main road, to be used for athletic purposes. Acting on the



suggestion, the land was bought and put to the use originally intended when the funds were raised.

Baseball has been a popular sport in all communities throughout Central Western Ontario for many years, and some outstanding teams have developed in that part of the Province. As an example, we cite the team of the town of Harriston, who were the undisputed national champions during the '90's, and even of international repute on this continent.

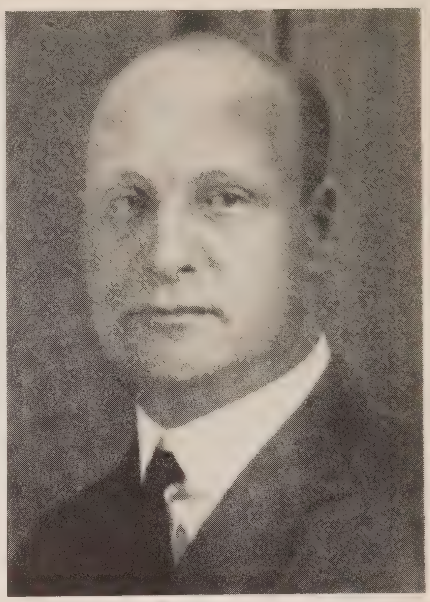
The ascending popularity of softball during recent years has enabled even the small hamlets to have teams. Alma has been in the forefront in the game and successful in capturing the championship more than once. The Alma team in the Girls' Softball League also has the enviable record of having defeated all comers.

Prior to the past summer all games had to be played by daylight, and the farmers of the district complained that this prevented their witnessing any of the high-class baseball played by their teams. To meet this complaint the Alma Ball Club installed a modern flood lighting system on the local field. The installation consists of 26–1,500 watt units with open type reflectors. These, with the gate and refreshment booth lighting, give a total installed capacity of 40 kw. The installation cost approximately $2,500 and the average cost of operating the lights on each night of play is approximately $4.50. There is no doubt that the field will be popular and prove a benefit to the district. There is a seating capacity for 1,000 persons and on several occasions the attendance was close to this number. On the night of the official opening there were close to 3,500 in attendance. In addition to the nights of regular league games, there were nights during the season

when the field was used for special games, box lacrosse being the attraction on occasions.

In the installation at Alma we have another example of the manner in which Hydro may be put to the benefit of rural districts, in making possible amusements that could otherwise be obtained only in the larger centres. Other sections would do well to consider the example set by Alma and provide facilities so that the greater numbers may participate in and witness contests, within the areas of their communities.

W. Stirling Jaffray



W. Stirling Jaffray

Mr. W. Stirling Jaffray, Port Arthur, who for the past seventeen years has been associated with the Hydro-Electric Power Commission of Ontario as District Electrical Inspector for the District of Thunder Bay, passed away, after a serious illness, at the family residence, 24 Peter Street, Port Arthur, on August 20th last.

Through Mr. Jaffray's passing, it is realized that the Commission has sustained a very serious loss and has been deprived of a faithful and efficient employee, as he was most conscientious and painstaking in the discharge of his duties and earned the highest respect and esteem of all with whom he came into contact, and he carried out his duties to the utmost satisfaction of the Electrical Contractors, the Public and the Commission. Under him the quality of electrical installations at the head of the lakes has attained an excellence that compares favorably with any place in the province.

Mr. Jaffray was 43 years old and single. He is survived by his mother, his brother, E. L. Jaffray, an executive of the Board of Grain Commissioners for Canada, and one sister, Miss Mona Jaffray, with all of whom he lived; another sister, Mrs. Campbell Graham, of Victoria Road, Ont., also survives him.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Abitibi-Sudbury 132 kv. Line in Service

ON October 1, the Hydro-Electric Power Commission of Ontario placed in service a new 132 kv. double-circuit steel tower transmission line supplying service to the Sudbury mining district, and 25 cycle power is now available over this line to the International Nickel Company at Copper Cliff. This new long distance line extends in a southerly direction from Hunta (about 12 miles west of Cochrane on the Canadian National Railway) to Copper Cliff, near Sudbury, a distance of 190 miles. At Hunta the line connects with the transmission lines of the Ontario Power Service Corporation, a subsidiary of Abitibi Power and Paper Company.

The contract between the Commission and the International Nickel Company provides that the first minimum block of 16,000 h.p. shall be delivered on October 1, 1931, and, as it was impossible for the Ontario Power Service Corporation to complete its Canyon development by this date, a supplementary agreement was made whereby the corporation will supply the Commission with such power as it may require for the district up to an amount of 25,000 h.p from the existing development of the Abitibi Power and Paper Company at Island Falls until the Canyon development is completed, which it is expected will be on or about October 1, 1932.

Under the Commission's contract with the Ontario Power Service Corporation, the Commission agrees to take and pay for specified amounts of power each year up to October 1, 1936, when the entire amount of 100,000 h.p. is to be paid for.

From the map shown herewith it will be seen that from Hunta this new line runs almost due south to Timmins, through Porcupine mining district. Then it swings slightly west to follow the course of the Mattagami River, passing between the present Sudbury and Gowganda mining districts. In this section, it passes within a few miles of Westree and Shining Tree, is close to Fort Mattagami and not far distant from

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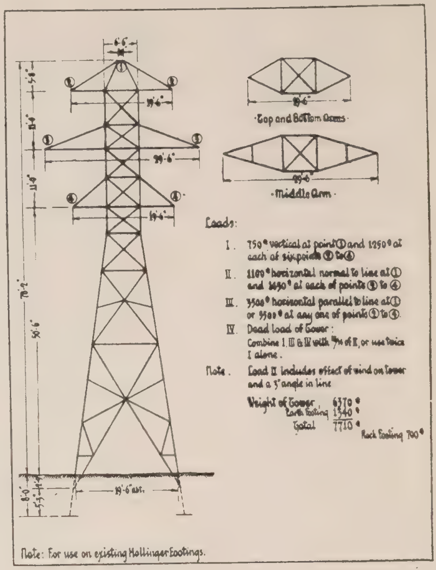
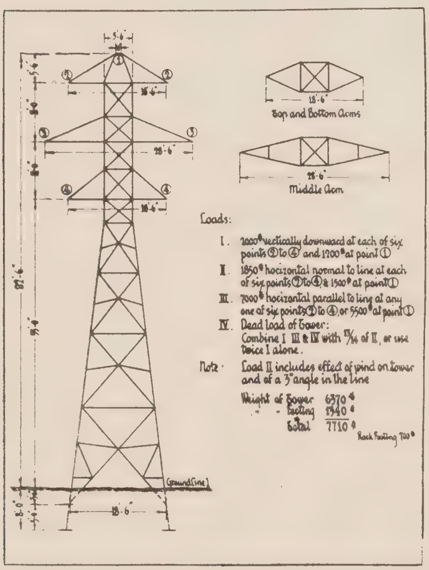
the new gold fields in the Matachewan area. Continuing south, it crosses the lines of the Canadian National again near La Forest, swinging easterly to its terminus near the International Nickel Company's



Outline of special suspension tower used on existing tower footings—Hunta to Copper Cliff 132 kv. line.



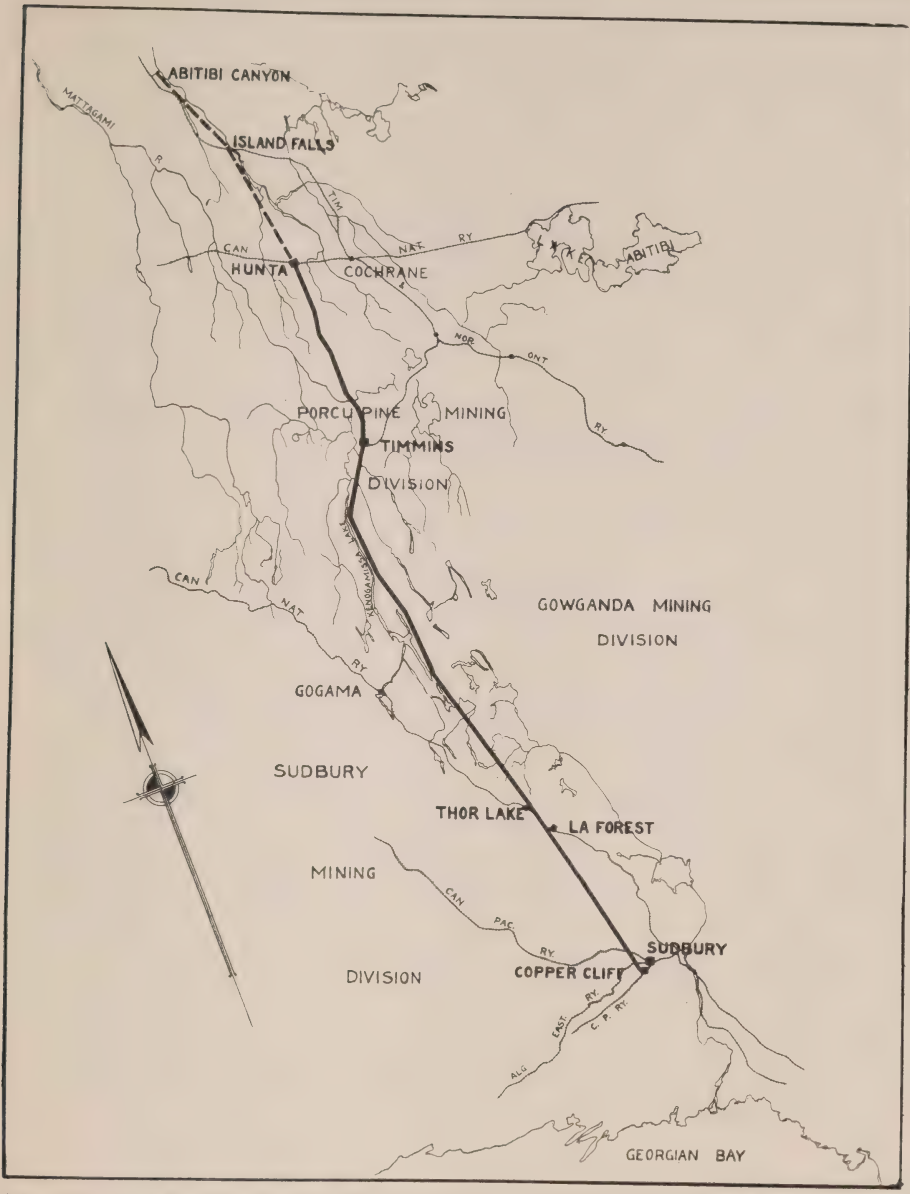
Outline of standard suspension tower used on Hunta to Copper Cliff 132 kv. line.

plant at Copper Cliff. Passing through these important mining districts, and being available as a source of power to all in this district who require power, the presence of the line cannot help but become an important factor in the development of this north country.

The supply of this power, therefore, may mark the beginning of a new era in the industrial development of Northern Ontario as the purchase agreement between the Commission and the Ontario Power Service Corporation insures a supply of sufficient power to meet the requirements of all of the basic industries that may be established in this district for some years.

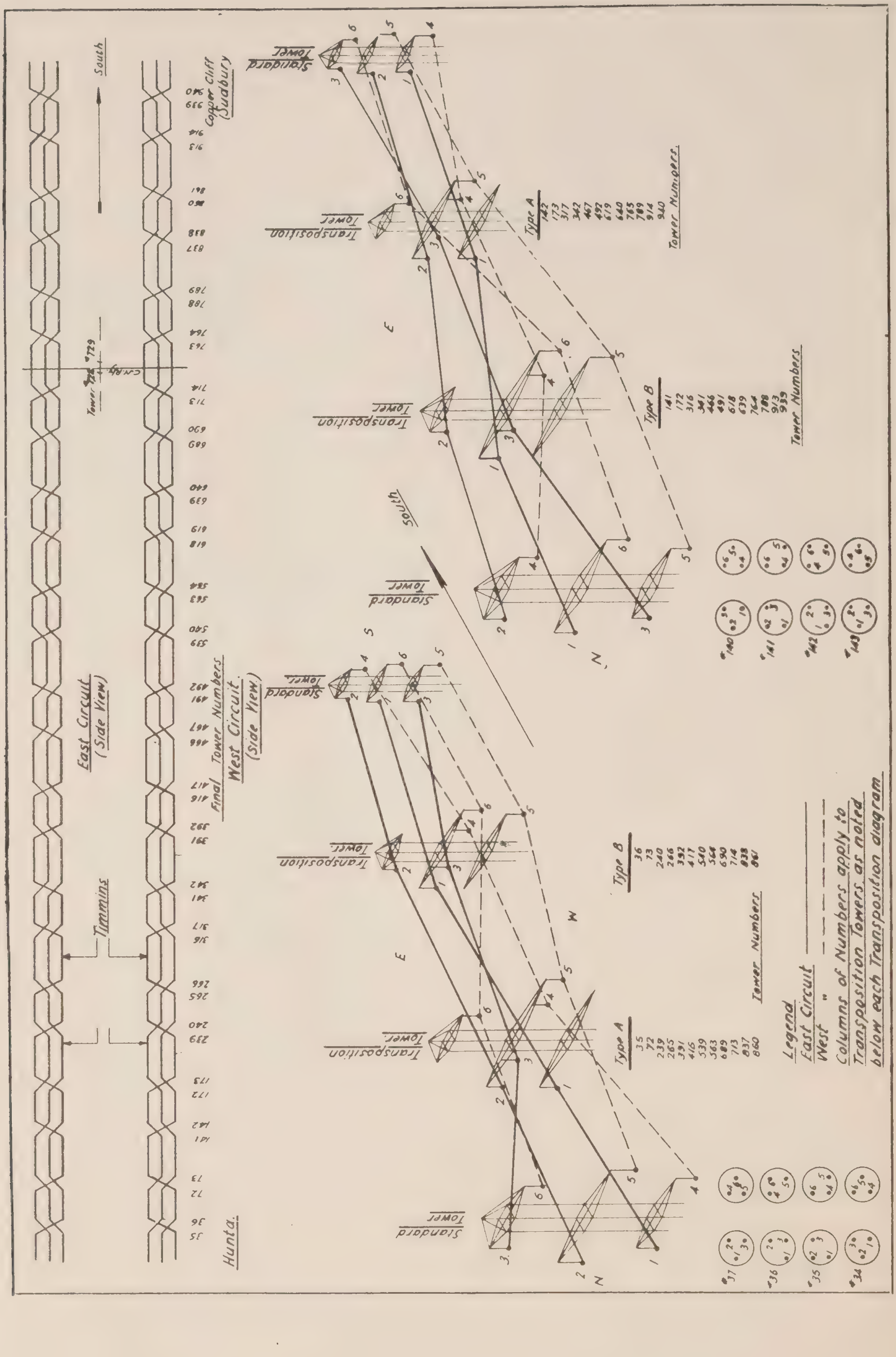
DESIGN FEATURES

From the design standpoint the line incorporates a number of interesting features. The method of



Map showing the location of the H.E.P.C. of Ontario's new 132 kv. line from Hunta to Sudbury through Northern Ontario mining districts.

obtaining the halting and reverse transpositions is an example of the latest practice. Instead of the customary special transposition towers being employed, the transpositions, every 5½ and 11 miles, are obtained with standard towers by using extra long middle and bottom arms. The transposition of lines is thus negotiated without any severe angles and



Connection details of halting and reverse transpositions used on 132 kv. line from Hunta to Copper Cliff.

without the use of dead-ends, as is clearly depicted in the diagram of connections shown herewith.

There were two types of construction employed: standard suspension and standard semi-anchor towers were used from Copper Cliff about 156 miles north; and special suspension and semi-anchor towers were used from that point north to Hunta owing to the fact that there already existed footings from the old Hollinger line. The standard towers have a base of 18 ft. 6 in., a height of 82 ft. 6 in. above ground, and were located at an average span distance of 1,056 ft.; whereas the special towers, erected on the existing footings, have an average span of 800 ft., a base of 19.6 ft. and a height of 78 ft. 2 in. above grade.

The load specifications are given in the tower outlines. The cable used was 336,400 cir. mils., a.c.s.r. and was strung for ½-inch ice and an 8 lb. wind pressure at + 30° fahr. Single ground wire of 5/16 inch, high tensile, galvanized steel was used suspended in flexible cradle clamps.

Another interesting feature is the use of aluminum armor rods with flexible cradle clamps in the suspension positions. This is not the first time that the Commission has used armor rods, but it is the first line of any length that the Commission has completely equipped with them.

For suspension positions, eight insulators were used (C.P. 4700 and O.B. 25622 suspension type), and in strain positions, ten (C.P. 2860) units.

Telephone Line

In order to maintain service over the line it was necessary to construct a private telephone line along the right-of-way. Actually, at the south end owing to difficult country, the telephone line is carried on the steel towers for some 30 miles, but for the remainder of the distance it is carried on a wood pole line spaced 35 ft. from the centre of the tower line. The telephone poles are located to give exactly four spans to every tower length and a transposition is made at the centre of each tower span, excepting where the line is carried on the towers and then it is transposed, of course, in each tower. The resulting co-ordination obtained from the power line and telephone transpositions is so good that telephonic communication is highly satisfactory.

The telephone line carried on the poles is No. 6 a.c.s.r., but on the towers its composition is reversed, being No. 6 steel covered aluminum centre, or one strand of aluminum to six of steel.

Housing and telephone accommodation is provided for patrolmen at the most advantageous positions along the right-of-way.

Construction Problems

The actual construction of this long line through the district known as the Precambrian shield, a region noted for its ruggedness and rocky character, involved many transportation problems owing to the inaccessibility of the route. Between Hunta and Timmins the line passes through the clay belt where there is from four to eleven feet of muskeg; below this the country is typical of much of the great Canadian shield, being heavily timbered, rocky and interspersed with innumerable small lakes.

During the summer of 1930, the right-of-way was surveyed, both on the ground and from the air. The clearing of a 100-ft. wide strip for the line—in itself the equivalent to the cutting of a miniature forest, 1,600 acres in extent—was commenced in the fall of the same year, and delivery of material was carried on throughout the winter when passable roads could be more readily made over the deep snow and frozen lakes.

All material was hauled from the railway, which in places is nearly 40 miles away from the right-of-way, either by teams with sleighs or by tractors drawing a small train of sleighs. Actually, the whole transportation problem was equivalent to moving 7,500 tons of material, an average distance of fifteen miles through the bush, though often in places single loads of 4 tons were transported a distance of 45 miles. Construction commenced in November, 1930, and progressed steadily until just recently when this work was completed and the final details of inspection and testing were carried out—the Commission's engineering and construction departments handling the complete job.

The following companies supplied material: power cable and armor rods, Aluminum VI Limited; steel towers, Canadian Bridge Company; insulators, Canadian Porcelain Company and Canadian Ohio Brass Co.; clamps, Line and Cable Accessories and N. Slater Company Limited.

A Letter of Appreciation

November 3, 1931.

F. A. GABY, ESQ.,
Chief Engineer,
Hydro-Electric Power Commission,
190 University Ave.,
Toronto 2.

DEAR MR. GABY:

Your esteemed letter of the 28th of October, advising that the staff of the Commission responded to the appeal of the Federation for Community Service, as presented to it through your Office, to the extent of $6,000, has come to hand on my return to the City.

This very generous action is deeply appreciated by all the Directors of the Federation, and especially by myself. It indicates a real spirit of sympathy and interest by the members of your staff towards those less fortunately situated in life than they are, and will go a long way to alleviate much suffering and provide relief at a time when, in our City, conditions were perhaps never so acute.

May I ask you to extend to every member of the staff of the Commission who took part in this splendid piece of work the heartfelt appreciation of those directing the affairs of the Federation.

Yours very truly,

(*Sgd.*) T. BRADSHAW.

Rapid 110kv. Transformer Station Construction in Eastern Ontario

By J. M. Harkins, Assistant Engineer, Electrical Engineering Dept., H.E.P.C. of Ont.

DUE to unusually low flow conditions on the Trent River, resulting in a reduced output of the Central District Generating Stations of the Hydro-Electric Power Commission, it became necessary during the Summer of 1931 to increase the amount of Gatineau Power being supplied to the Central District.

Previous to this time, Gatineau power had been transmitted at 110 kv. as far as Smiths Falls and there stepped down for distribution to the Central District (at 44 kv.), to the St. Lawrence District (at 44 kv.) and to the Rideau District (at 26 kv.). The transformers at this station consisted of a bank of three 5,000 kv-a., 63.5/25.4/4.16 kv. transformers with a 15,000 kv-a. regulating transformer for tap changing under load and a spare 5,000 kv-a. unit. The bank was connected star-star with the 4.16 kv. tertiary in delta.

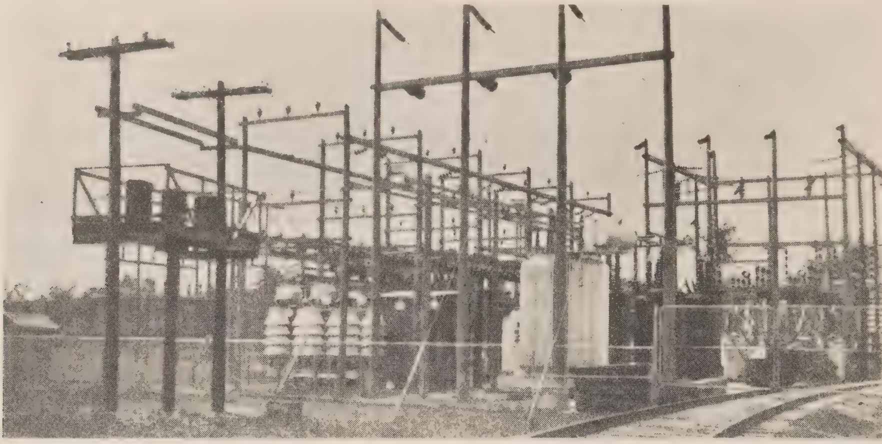
The distance from Smiths Falls to Belleville via Kingston over the existing lines at 44 kv. imposed a definite limit upon the amount of power which could be transmitted. Any increase beyond this limit caused the systems to pull out of step as the steady state power limit was exceeded.

As the amount of power required exceeded this steady state power limit, it was decided to anticipate the construction programme scheduled for the Fall of 1932 by erecting a 15,000 kv-a. step-down station at Kingston and convert the Smiths Falls-Kingston line to 110 kv. This, of course, would reduce the total reactance drop from Smiths Falls to Belleville and so increase the power limit. Fortunately provision for this change had already been made in that the line was already insulated for 110kv. although operating at 44kv.

As the water shortage was developing rapidly, it was not feasible to await the building of three new 5,000 kv-a. transformers for the station at Kingston, and therefore the following procedure was adopted.

The three 5,000 kv-a. units with the regulating transformer at Smiths Falls were moved to the new Frontenac Transformer Station at Kingston and in their place at Smiths Falls a three-phase bank was made up by using the spare 5,000 kv-a. transformer for one phase and two 1,250 kv-a., 63.5/26.4 kv. indoor water-cooled transformers in parallel on each of the other two phases. It was of course necessary to change the four 1,250 kv-a. transformers from indoor to outdoor service by replacing bushings and also to provide for the water cooling of these units.

As there was no tertiary winding on the 1,250 kv-a. units, and as the bank was connected star-star, a three-phase, 1,500 kv-a., 44/2.4 kv. transformer was connected star-delta with its high voltage neutral connected to the 44 kv. neutral of the



View of Smiths Falls transformer station after changes were made.

main bank in order to provide a path for third harmonic currents. This 1,500 kv-a. transformer was also useful in supplying 2,400 volt power to the old tertiary bus (formerly 4,160 volts) from which the Rideau System, the station service bank and certain rural customers had received their power.

Therefore, before the first 5,000 kv-a. transformer could be removed from service, thus cutting off the supply to the 4,160 volt tertiary bus, the 1,500 kv-a. star-delta transformer had to be cut in, the tertiary bus changed over to 2,400 volts and all services therefrom adjusted for the new voltage. This was done by changing the station service transformer to the 2,200 volt tap, re-connecting the 750 kv-a. transformer feeding the Rideau District to delta connection on the low voltage side, and by inserting a bank of one-to-one transformers connected delta-star on the line feeding the rural customers. The change in the tertiary bus voltage, of course, meant the removal from service of the regulating transformer which had been used for under load tap changing.

On June 21st, an interruption was obtained and all the above changes carried out, and in addition, the spare 5,000 kv-a. transformer was cut into service, releasing the blue phase 5,000 kv-a. transformer and the 15,000 kv-a. regulating transformer for shipment to the new Frontenac Transformer Station.

Two 1,250 kv-a. transformers were then set up in parallel in the space vacated by the blue phase transformer and a complete water cooling system installed for the 1,250 kv-a. units.

On July 1st, the second interruption was obtained, the blue phase 1,250 kv-a. units connected, the white phase 5,000 kv-a. unit removed and two 1,250 kv-a. units set up in its place and connected. This released two more 5,000 kv-a. units (one from the spare position and one from the white phase), making three in all for Frontenac Transformer Station.

Tests were made which indicated

that the 1,500 kv-a. star-delta transformer was quite effective in providing a path for third harmonic currents generated in the star-star connected main transformer. Slight inequality between the voltage ratios and the regulation of the 1,250 kv-a. and 5,000 kv-a. units did not produce any detrimental effects. Removal of the corrective bank, however, produces a very high residual voltage and makes a very perceptible increase in vibration of the main transformer bank.

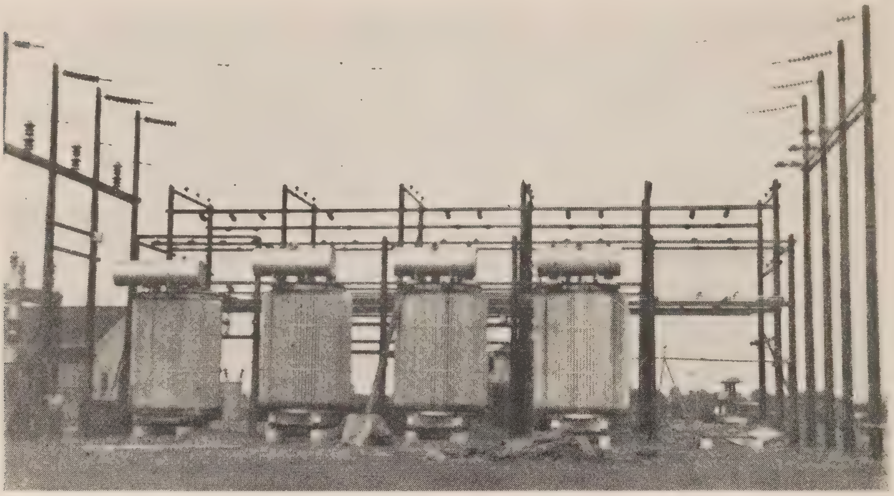
While the above work was being carried out at Smiths Falls, construction was proceeding at Frontenac Transformer Station and at Forfar Distributing Station. The former station is for the purpose of stepping down the 110 kv. power at Kingston to 44 kv. for supply to the Central District after the Smiths Falls-Kingston line was changed to 110 kv. The latter station is mid-way between Smiths Falls and Kingston, supplying rural customers in the Rideau Lake District, and, of course, its voltage would be changed to 110 kv. when the line was changed over to its new voltage.

Frontenac Transformer Station has a main transformer bank consisting of three 5,000 kv-a., 63,500/25,400/4,160 volt, single-phase units with a regulating transformer for tap changing under load, the whole stepping down from 110 kv. to 44 kv. A tertiary winding is provided in each transformer which supplies a tertiary bus from which the regulating transformer derives its excitation. The regulating transformer has three windings which are connected between each 44 kv. phase and the neutral point. The exciting winding is supplied by means of a variable ratio auto-transformer and by varying the voltage applied to the exciting winding, the phase voltage may be increased or decreased.

The station structure is of wood pole construction with concrete foundations for the transformers and circuit breakers. It is designed for the ultimate installation of a 110 kv. oil circuit breaker and three 44 kv. breakers. At present, the high voltage breaker is omitted and only one 44 kv. breaker is installed. High and low voltage arresters are supplied with a maximum rating of 121 kv. and 50 kv. respectively. The station service is supplied from the 4,160 volt delta tertiary winding by means of step-down transformers.

The site of the station is on rock with an over-burden of about 18 inches of soil. These conditions made effective grounding difficult and, in order to overcome this, a coil of wire was inserted at the base of each pole and also under all foundations. In addition, copper ground plates were installed in two holes blasted in the rock at points of natural drainage and these holes were filled with coke and salt. All rain water falling on the roof of the control room and operator's cottage are led into these ground holes to assist in keeping them moist. These precautions resulted in obtaining a very low resistance in view of the conditions.

A potential device consisting of two series condensers and a potential transformer was connected to the 110 kv. neutral designed to trip the low voltage breaker in case of a ground on the high voltage line. The low voltage



Frontenac Transformer Station—Main 15,000 kv.-a transformer bank and regulating transformer.

breaker is also equipped with overload and ground relays to trip in case of trouble on the 44 kv. line.

Forfar Distributing Station was entirely remodelled and two 500 kv-a., 110/4.8 kv. transformers installed in open delta to supply three-phase, 4,800 volt power to the district served. The station is provided with a three-phase, 110 kv. air break switch, fuses and spill-over gaps protecting the above transformers and the usual low voltage metering and switching equipment. Service was maintained on the original 44 kv. transformer until the 110 kv. supply commenced.

On July 12th, the Smiths Falls-Kingston line which was insulated for 110 kv. although operating at 44 kv. was changed over to the higher voltage, Forfar Distributing Station livened up and placed on load and Frontenac Transformer Station made alive at 110 kv. and synchronized with the Central District. This relieved the Smiths Falls Transformer Station with its new capacity of 7,500 kv-a. of the Central District load allowing it to serve the Rideau and St. Lawrence Districts only.

Pull-out tests conducted after the change-over showed an increase in power limit of 40 per cent. over the old condition and this increased capacity has been absolutely essential in combating the effects of water shortage during the Summer and Fall.

This work was carried out rapidly, the entire change-over being completed and in service two months from the date of authorization of the work. All plans were prepared and the field work carried out by the Commission's Engineering and Construction staffs.

Application of Hydro-Electric Power to Farm Work

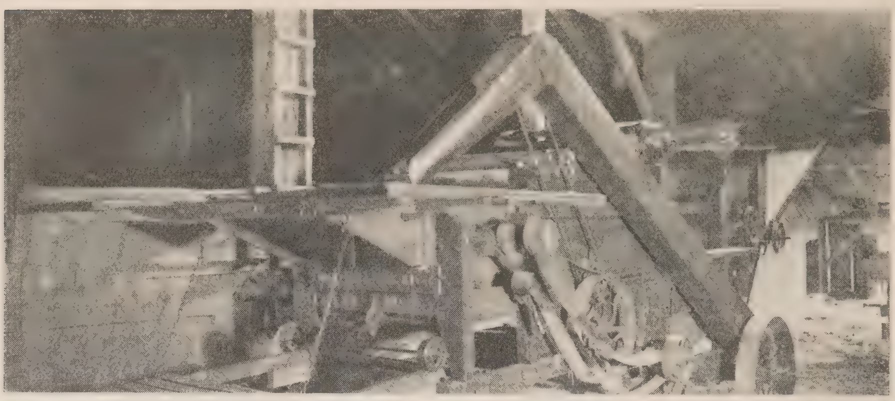
Article No. 22

(Not to be reproduced without permission)

THE scenes taken on the farm of Henry Bowman at Lexington, in Waterloo Township, about four miles north of Kitchener, Ontario, illustrate the advancement during one hundred years in relieving work on a farm. This farm was first settled on by Henry Webber, grandfather of Mrs. Henry Bowman, in the year 1816. At that time the pioneer depended upon his own ingenuity as to design and manufacture of such things as were necessary for his work, and consequently had to be adept in many other trades than that of farming. Mr. Webber was systematic in his work, as are also his successors, and this with a commendable pride for old things that are still good or useful, has resulted in a collection of equipment rarely to be found in Ontario.

The barn shown in one of the illustrations was built in 1823. This is a double-decked building with stabling in the basement. The grain when hauled from the fields is first stored in the upper section. When threshing, the straw falls through an opening in the floor to the lower section, where it is mowed away. The thresher, driven by a 12-horse

Farm buildings and home of Henry Bowman. At top:—The old walnut tree at the right of the picture was left standing when the land was originally cleared. At bottom:—The double deck barn was built in 1823.



Sweep power threshing machine which requires six teams of horses to drive.

sweep power, was put in about 1895 and is still doing service, showing very little wear. Although the sweep power is equipped with devices to keep the horses at their work, yet the driver must be retained and he cannot neglect his duty for one moment. An equalizer device is provided, whereby when a horse begins to lag he gets a pull on the head. The driver in the illustration is giving his attention to the horse in the foreground that wants to take a rest, while the outside horse directly behind the driver is taking advantage of the driver's back being towards him. This horse sweep power also drives an oat roll in the granary. If adapted to electric service, a 5 h.p. motor could do the same work, though the sweep power calls for six teams of horses.

The shop was built in 1848 and is divided by a partition into two sections. One section is devoted to washing, dairy work, and the preparation of fruits and vegetables. The other section is used for forge, carpenter shop and tools. In this building there is a place for everything and

Sweep power driving threshing machine. The driver works continually with both voice and whip, for, should he stop so will the horses. A 5 h.p. electric motor could do the same work.

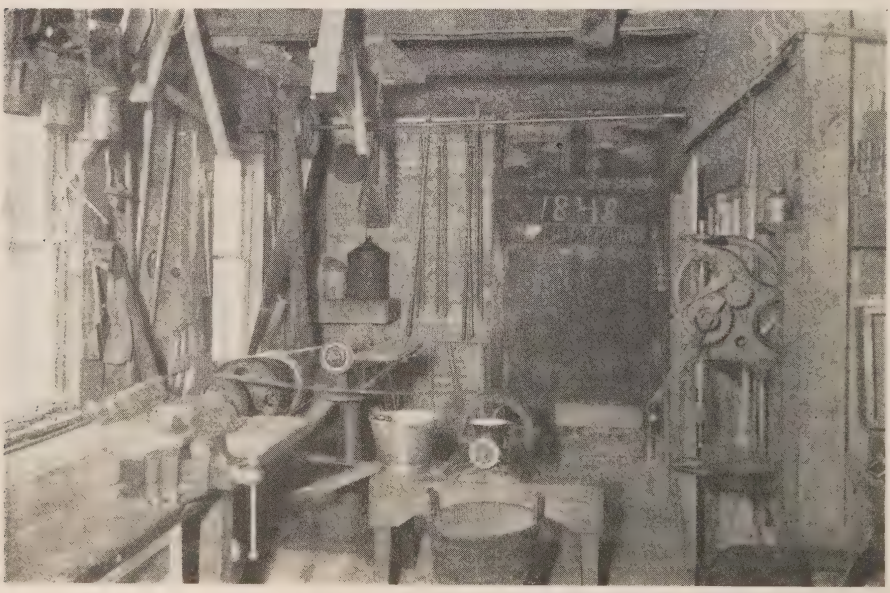
Three horsepower motor belted to line shaft driving power tools and woodworking shop. The large tub is about 90 years old and was made on the premises as also many of the others shown along the wall. These have given way to the electric washer, though the modern type churn is still hand operated.

Section of shop used for dairy and fruit and vegetable drying. The bucket, cider press and baskets are relics of by-gone days but still in use.

Forge and wood-working shop showing many old pieces of equipment. The wood shaver near the stairway was a great help in making split shingles, in addition to other uses.

everything is in its place. Such power as is used in this building is provided by a 3 h.p. motor, belted to a line shaft.

The pictures taken in the shop tell their own story, and it is not necessary to refer to all of the things shown. There are some, however, that deserve mention, and these will be referred to briefly. In one we see an electric washing machine beside an array of wooden tubs. Many of



A corner in the shop showing some of the power driven tools. The building was erected in 1848.

Saw table in woodshed which has many uses in making farm equipment, besides sawing wood. The man on the buck saw is giving his interpretation of the hardest way to cut wood.

these tubs were made on the premises, the large one on the floor being about 90 years old. This tub is about 4 feet in diameter and 2 feet deep. The common practice in those days was to put in about half a barrel of soft water, the washing and some home-made soap, and then someone would tromp around the edge of the tub, thereby forcing the soapy water through the clothes. The electric washer may not be much different in principle, but its saving of labor is great. The fruit and vegetable dryer, a modern piece of equipment, shows the abandonment of the old method of drying by hanging racks from the rafters or ceiling of the kitchen for that purpose. The forge and wood-working sections still provide for hand work only. It is here that much of the cooperage and other wood working was done, as also the general blacksmithing for this and the neighbouring farms. The power drive on the meat chopper has proved itself of undoubted advantage. On one occasion Mr. Bowman sold a quarter of beef which was to be delivered as sausage meat. In order that he would know the cost of grinding the meat, Mr. Bowman noted the power registered on his meter to do the work, and found that the increase in his bill for all of the power used was eight cents.

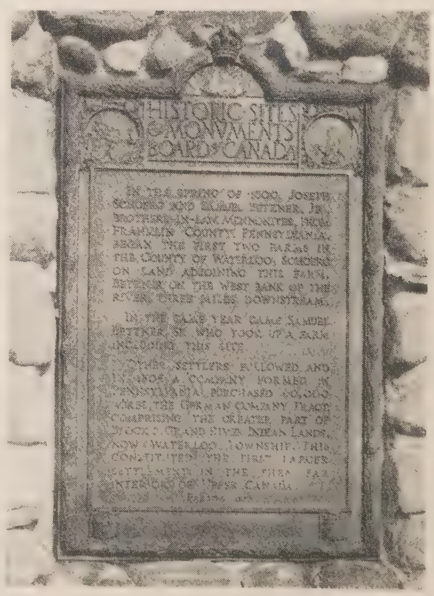
The saw table in the woodshed, being adjustable, permits it being used in roughing out wooden forms for whippletrees, reaches, wagon tongues and all other such work as required on the farm. When cutting wood for winter use, the table is changed.

Both the house and the barn have electric lighting. In the house there is an ample supply of convenience outlets, the lights being on switch control. In both house and barn, provision has been made in the wiring for the installation of further electrical equipment.

Kitchen yard on Henry Bowman's farm. (Note the cement walks between buildings.)

The original farm was 400 acres, part of which was in another section. The present one consists of 123 acres only, of which 80 acres are in cultivation and 8 acres in bush, the balance being pasturage. The same care has been taken of the land as is indicated by the interior and surroundings of the buildings, which has resulted in a picture of industry and thrift, of which there are many in Waterloo Township.

Waterloo Township was the first larger settlement in the then far interior of Upper Canada. In the spring of 1800, two men named Joseph Schoerg and Samuel Betzner, Jr., made a trip from Franklin County, Pennsylvania, apparently by water up the Grand River into what is now Waterloo County, looking for a place to settle. Late one day they arrived at a point near the site of the present town of Preston, where they spent the night. Here they settled



Memorial tablet to the pioneers of Waterloo County on monument tower erected to their memory about $1^1/_2$ miles west of Preston on the Grand River.

on two farms not far apart, with the river as a route of travel between them. These two were followed by others, and in 1805 a company was formed in Pennsylvania which purchased a tract of 60,000 acres, which was called the German Company Tract, and is now Waterloo Township. Henry Webber followed with others who came later.

Demonstration at the Provincial Plowmen's Association Plowing Match

THE International Plowing Match and Farm Machinery Demonstration was held on October the 13th, 14th and 15th, 1931, just outside the City of Peterborough and adjacent to the Toronto-Peterborough Highway. The most noticeable demonstration was that put on by "Old Man Weather" who produced a number of samples of steady, persistent rain which, if not appreciated, were certainly vigorously discussed by everybody present. The farmers called it "a nice warm rain" but the remarks from the owners of the candy floss machine and the hot dog stands were quite unprintable. However, the effect of the wet weather was that the spectators took refuge in the "Hydro Tent" so that a steady stream of steaming visitors discussed and criticized the various phases of "Hydro Service" or crowded around the pipeless stove thoughtfully provided by Mr. Purcell. Half of the Hydro Tent showed the advantages of electric drive as applied to farm machinery and the various types of churns, pumps, milking machines and choppers operated by electric power attacted the attention of all the farmers. The Woods electric chopper which has been developed to produce 100 lbs. of chop per hour,

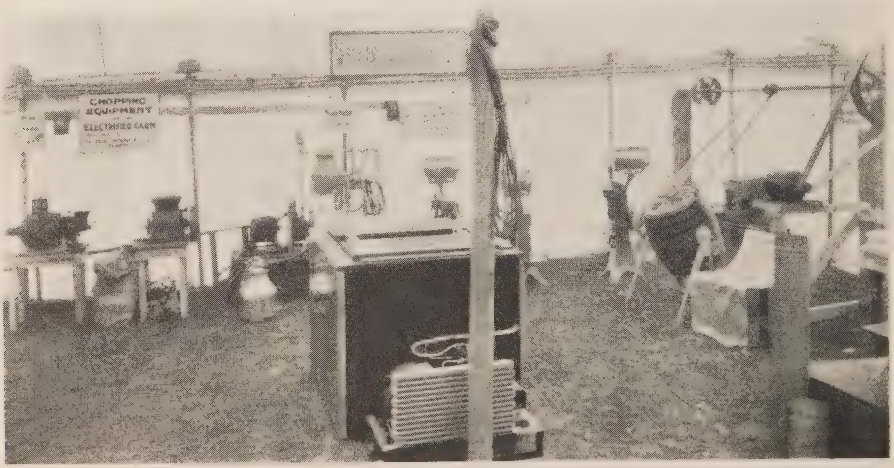
Hydro Tent at the plowing match.

Part of household section—Hydro demonstration.

driven by a 2 h.p. motor, was the centre of much discussion. The other half of the Hydro Tent had an attractive display of household appliances. Nearly every type of electric range was shown, the many types of small rangettes now on the market attracting considerable attention. The electric heaters and fireplaces were at a premium.

The Commission is indebted to the many manufacturers who co-operated to make this exhibit a success, particularly to the Lister Pump Co., the W. C. Woods Co., the R. McDougal Co., The Wagner Motor Co., The Kelvinator Co., and last but certainly not least the Peterborough Utilities Commission who did everything possible to assist the Commission to make this exhibition a success.

While the attendance was only about 30,000 this year owing to bad weather, the Plowing Match had the greatest number of entries of any year in its history. In 1911 the number



A corner in the barn and dairy section.

of entries was 30; this year there were 500—about 60 more than at Stratford last year.

The Silver Plate donated by the Chairman of the Commission, Honourable J. R. Cooke, as a first prize for tractor plowmen in a contest among men who had never won a prize at an International Plowing Match before, was won by Albert Smith of Malton.

On the last day an excellent banquet was given by the City of Peterborough in the Market Hall to all competitors, exhibitors and officials in the Plowing Match at which the Minister of Agriculture was present. It is noticeable what a healthy organization the Plowmen's Association has grown into and what an attraction the Plowing Match has become in this part of the Province. The Hydro exhibition and the provision of electric light and power for the exhibitors is now a necessary and integral part of the whole Demonstration.

James Clerk Maxwell Centenary

THE centenary celebrations in England of the discovery by Michael Faraday of electro-magnetic induction were immediately followed by the celebration of the one hundredth anniversary of the birth of James Clerk Maxwell, the other great founder of the modern science of electricity and magnetism.

Born at Edinburgh on November 13, 1831, of a well-known Scottish family, James Clerk Maxwell was educated at the Edinburgh Academy, the University of Edinburgh and at Cambridge. He held the chair of natural philosophy in Marischal College, Aberdeen (1856-60), and the chair of physics and astronomy in King's College, London (1860-68). He then resigned and retired until 1871 when he was summoned to become the first holder of the newly founded professorship of experimental physics in Cambridge. He died at Cambridge on November 5, 1879.

It is said that when Maxwell first went to Edinburgh Academy at the age of 10 he was anything but a success. "He was at first regarded as shy and rather dull. He made no friendships and spent his occasional holidays in reading old ballads, drawing curious diagrams and making crude mechanical models. This absorption in such pursuits totally unintelligible to his school fellows, who

James Clerk Maxwell
1831—1879

were then ignorant of mathematics, procured him a not very complimentary nickname 'Dafty'. About the middle of his school career, however, he surprised his companions by suddenly becoming one of the most, brilliant among them, gaining prizes and sometimes the highest prizes, for scholarship, mathematics and English verse."

Maxwell's contributions to scientific societies began in his 15th year, when Professor J. D. Forbes communicated to the Royal Society of Edinburgh a short paper of his on a mechanical method of tracing Cartesian ovals. Living in an age when the urge to specialization was far less insistent than it is to-day, he was, therefore, able to make pioneering contributions of first class importance in many branches of science. In the electrical field his fame rests mainly on his equations to the electromagnetic field. These equations originated in the study of what must be regarded as a very crude model, consisting of cog wheels and idlers which he framed to represent mechanically Faraday's observations. It has been said that Maxwell was constitutionally incapable of thinking wrongly in any problem in mechanics. In conjunction with Fleming Jenkin and Balfour Stewart, he made the first absolute determination of the ohm. Maxwell's electro-magnetic theory led to the conception of electrical disturbances due to changing electric or magnetic field, as waves the velocity of which is equal to that of light. He also showed that the chief properties of light could be accounted for in the same way.

The kinetic theory of gases received enormous developments from Maxwell, who in this field appeared as an experimenter as well as a mathematician. He derived the law of distribution of velocities of the molecules of a gas, which is known as Maxwell's law. He wrote a text-book, the *Theory of Heat* which was an immense help to students. Other contributions of Maxwell were .n the fields of astronomy and stresses in structures and materials.

On Wednesday, September 30, memorial tablets to Michael Faraday and James Clerk Maxwell were unveiled in Westminster Abbey. These memorial tablets are in the nave of the Abbey beside the tombs of Sir Isaac Newton and Lord Kelvin.

The Maxwell centenary celebrations were held at Cambridge on Thursday and Friday, October 1st and 2nd. The opening of the celebrations was attended by nearly 100 delegates representing the principal educational bodies and learned societies of the world.

Radio Interference
V

Co-operation

IN preceding issues, radio interference has been discussed as to its nature, sources, location and suppression, but the important matter of co-operation between broadcast listeners, power companies and the Department of Marine towards its suppression has not been touched. The interference may originate in a fault, or be due to faulty design of appliances or of supply circuits, but on the other hand the broadcast listener's receiver may be too sensitive for the locality in which it is used.

Wherever radio interference is experienced, it is most desirable that the broadcast listener himself endeavour to locate the source, testing any appliances which may be in operation in his home at the time by turning each off for a minute or so, and even shaking his radio set to see if there be anything loose in it. He should disconnect the lead-in wire to prove whether or not the interference is being brought in by it. Unfortunately, it is not always possible for the source to be located readily, but having made a few attempts to find it, the broadcast listener should be able to make a comprehensive report on the nature of the interference, and any observed variations, which will be of assistance to those who carry the search further. His report, if his observations have been made carefully, may even be sufficient in itself to enable the more experienced trouble-searcher to know what is at fault.

The Radio Branch of the Department of Marine, Ottawa, is ready at all times to help in the search for sources of interference, and maintains a staff and a number of radio equipped cars for this purpose. Any cases of serious interference, if the efforts of the broadcast listener do not definitely locate the source, should be referred to the Radio Branch, with as complete a report as possible on the tests and observations that have already been made.

It is fortunate for Canadian broadcast listeners that members of the Department are so much interested in the problems of suppressing interference and so untiring and successful in their efforts to this end. Apparently the Dominion Government is the only government which provides a regular service for this purpose. Many public utilities, however, maintain an electrician, or a small staff, for the investigation and suppression of interference from their lines for the benefit of their customers.

Interference Levels

Measurements of field strength of signals, and of interference, have been made in several cities and, in many instances, the level of signal strength of distant stations has been found much lower than the interference level may reasonably be expected to be. Although steps may be taken to

reduce interference from certain sources, which may be located, the situation appears to be that there is an irreducible level of interference in certain localities which must be taken as a practical fact, *e.g.*, interference from street cars, elevators, etc., cannot be eliminated under present standards of construction.

The broadcast listener may frequently complain about the interference he experiences. In 300 such complaints, measurements were made and the interference level was found to be very low. In the majority of these cases the receiving sets evidently were too sensitive for the localities in which they were being used.

Satisfactory reception should not be expected on field strength less than a fixed amount from any broadcast station. Where there is local interference, the minimum field strength must be increased, and therefore the broadcast station must increase its power if it desires to be heard in these districts.

It is not possible to set any fixed minimum interference level, however, as the seriousness of the interference will vary with the sensitivity of the receiver but in congested districts the noise level cannot be expected to be less than a certain amount.

Salesmen Can Assist

Many engineers feel that receivers are being over-advertised as to their distance range, and that education is necessary in sales organizations as to what features should be advertised, and what matters should be given consideration in each individual sale of a receiving set. These matters would include the interference level of the district in which the receiver will be installed and the desire of the purchaser as to distance range.

As one engineer, representing a public utility company, very fittingly sized up the situation: You want to buy a motor car and approach a dealer, who, in extolling the merits of his cars, impresses upon you that these cars will attain a speed of 70 miles per hour. You may buy the car, but certainly not with any intention of running it at this speed continuously, nor expecting lasting satisfaction from it if you do. The radio public, on the other hand, are often led to expect operation at highest sensitivity at all times and under any circumstances, with interference or without, in fair weather or through atmospherics. The result in many cases is dissatisfaction with the receiver performance, and instead of realizing that they are expecting more from their sets than is reasonable in their particular locations, and with existing weather conditions, some radio listeners send in complaints of the interference and apparently expect the power or traction companies to reduce it to zero level. The power companies, therefore, are besieged with complaints, and may not be to blame, but usually do their utmost to suppress any interference caused by their systems.

A suggestion has been offered that manufacturers build two types of sets, one having a limited sensitivity for use in cities and another with very high sensitivity for the man who lives in the country, and sell these according to the location where they are to be used. This would help the city dweller immediately to realize that he

cannot expect as good reception as those who live away from the city and its interference. Another suggestion is that a set be built with two sensitivities, one for usual city use and the other for country use, or for unusually good conditions in cities and towns.

For towns which have no local broadcast stations, the suggestions are still good. Usual interference may be present there also, and the listener should not be led to expect as great a range of distance when in a town as when a little distance from it.

Mutual Assistance

In the locating and suppression of radio interference there should be the closest co-operation between broadcast listeners, public utilities, and the Department of Marine. The best results can be obtained only by each giving to the others the information and evidence available bearing on the case, together with carefully considered opinions. Early conclusions, however, may be misleading rather than helpful.

The Radio Branch, Department of Marine, should be advised in every case of the existence of interference, with as much information as possible as to its nature, frequency, and other characteristics in each particular instance. Their assistance is assured, if possible, whenever required. The staff and equipment of the Department are available and greatly aid in any search. Even though their assistance be not required, however, they should be advised of the details and conclusions in each case as a means of enriching their store of knowledge on the subject and to allow of comparison of characteristics of many similar cases.

Co-operation is the pathway toward most successful suppression of radio interference. This co-operation can be most freely given, and also will be most effective, when each party or group concerned fully understands the characteristics of radio interference, and some of the limitations of even the best known methods of suppression. Much can be done, but there still remains much that is impossible to cure.—*F. K. D.*

Association of Municipal Electrical Utilities

NOMINATIONS FOR 1932

The Scrutineers' report showing the results of the nominations for officers of the Association of Municipal Electrical Utilities for the year 1932, and which are derived from the recent primary ballot, gives the following results:

(* These names to appear on the election ballot.)

PRESIDENT: *C. E. Schwenger and *J. W. Peart.

VICE-PRESIDENT: *O. M. Perry, *T. W. Brackinreid, D. B. McColl, R. S. Reynolds, A. B. Manson, C. E. Schwenger, A. B. Scott, W. E. Reesor, J. E. Teckoe, E. V. Buchanan, E. I. Sifton, E. J. Stapleton, O. H. Scott, J. R. McLinden, C. A. Walters, J. E. Brown and H. G. Hall.

SECRETARY: *S. R. A. Clement, O. H. Scott and *W. B. Munroe.

TREASURER: *H. T. Macdonald, *B. Faichney, P. F. Seibert, R. P. Darrell and D. J. McAuley.

Directors From the Membership at Large: *O. H. Scott, *E. V. Buchanan, *J. E. B. Phelps, *R. L. Dobbin, *R. S. Reynolds, *E. J. Stapleton, *C. T. Barnes, O. M. Perry, W. E. Reesor, H. F. Shearer, W. R. Catton, T. W. Brackinreid, C. A. Walters, V. S. McIntyre, A. B. Manson, G. E. Chase, J. J. Heeg, R. H. Martindale, D. B. McColl, P. B. Yates, W. E. Wallace, E. I. Sifton, J. G. Archibald, H. S. Brown, A. W. J. Stewart, A. M. Bowman, E. E. Bowley, J. W. Peart, A. C. Herrington, C. E. Brown, W. G. Breen, S. Buckrell, H. W. Doerr, F. D. Hubbell, H. G. Hall, R. B. Hanna and J. M. Blue.

District Directors:

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The Romance of Measurement

A Measuring Stick is a Scepter in the Hand of Science

By Henry D. Hubbard, National Bureau of Standards

WHAT scope and sweep there is in measurement, from stars to atoms, timing radio echoes from distances beyond the moon, measuring temperatures on other planets, measuring the rate of cooling of our sun, measuring the age of our earth—measuring almost everything. The slow rise of the art of measuring gave no sign that in this century it would rise to a commanding place in human affairs.

In the days of old a poor man asked a wise man, "Why am I poor?" The wise one cut a staff thigh high, cut notches upon it a hand's width apart, and said:

"I give you the scepter of success—a measuring stick—for measures rule the world. They come in pairs; the measure of the sandal must match the measure of the foot. Always two matched measures. So all things are made to measure. Let this stick measure what you make, measure it well for its use. Three loops of cord will make the stick a balance to weigh what you buy or sell. Set it upright in the sun and the stick will measure the shadow hours of time;

allot them to thy tasks, Tune thy life to its circling shadow. When noon shadows are long it is time to plant. Measure your share and your brother's. Make wisely, measure truly, trade justly, and you will prosper."

Down the ages came the measurer's art by which things are dimensioned for use, by which time and place are measured for every fact and act of man. A measuring stick is indeed a scepter in the hands of science, a tool of discovery, record, and use of exact knowledge. Measures do miracles when we match the measured curvature of glass to the measured defect of the eye and thus restore sight to age and perfect the vision of youth.

Commerce is the exchange of measured things. Every transaction involves five measures: Quantity, quality, value, place and time. All are measured. Quantity in number and unit; quality in measures of its properties; value in terms of weight of gold; place east or west of Greenwich, north or south of the Equator, up or down from sea level; time in terms of the turning earth—the clock—and its trip around the sun; the calendar.

Success is matching a measured need by a measured means—shoe to the foot, glove to the hand, girder to the bridge, powder to the cartridge, inlay to the tooth, key to the lock. Key and lock may be measured to a thousandth of an inch, but some measures are not made in units. Without a unit a singer matches by ear the pitch of her voice with the measured pitch of the piano. Without a unit the violinist varies the notes to produce perfectly pitched melody. If a boy is to jump a ditch he first measures it with his eye, not in inches but effort, which he matches with his own effort to clear the ditch. His jump is as truly measured as if he used a unit.

The shoemaker of Old Pekin makes shoes with no unit of measure, no measuring scale—a strip of blank paper and his thumb nail are his measuring tools. He transfers the foot measures to his paper strip, using his thumb nail as a marker. He transfers the measures to his leather to make perfectly fitting shoes without a unit of length.

The Chinese have units but they differ for each trade and place. A cloth merchant may buy and sell at the same price. He buys by a long measure, sells by a short one, and thus makes a profit. The Chinese travel unit of distance, the "li," is longer on easy roads, so that downhill to town may measure fewer "li" than the uphill trip home. The Chinese rice weight unit is the "catty", but the "catty" unit becomes smaller and smaller from the rice field to tidewater as the coolies carry the rice. The reason is simple, each coolie takes out his pay in rice. The rice bags reach seaboard lighter for the tax, but weighing the same number of "catty" as when they started.

Crude measures pass and modern measures are uniform and accurate in comparison. Scientists measure how things happen in nature and experiment—at what heat and pressure a crude oil cracks into gasoline, carbon dioxide becomes "dry ice" or air becomes a liquid and flows like water.

Science makes vast numbers of such

natural measurements — melting points of solids, weights of atoms, lengths of light waves, properties of materials. In such measures lie latent the means to alter nature almost at will and make it serve our purpose with almost magical power. Such measures build civilizations. They are the numbers which rule the world of enterprise.

Measuring tools evolve from simple origins—a stick, a shadow, a gourd, a stone—to-day measuring devices number thousands and give man new senses, enabling him to detect "invisible" light, to feel magnetic forces, to sense a thousand things otherwise unknown. With the Bose crescograph one can see the movements of growing plants. A lens and mirror device is used to measure the diameter of stars, a feat comparable to measuring a quarter dollar by an observer 50 miles away.

The radioactivity of radium is measured by the movement of an electrified strip of gold foil. Electrified quartz threads are sent up 10 miles to measure cosmic rays. A 6-ounce device rises in a balloon 16 miles to bring back automatic weather records of temperature, pressure and humidity. We measure air moisture by the stretch of a hair. In the Antioch Light fog-signal device, 100 human hairs are so set that in fog dampness they stretch and turn on the fog signal.

Ingenuity in measuring rarely excels the bit of genius by which we can literally hitch our wagon to a star. An automatic device in Paris catches a star's image at meridian, turns its light pulse into an electric pulse, amplifies it, and broadcasts it as a radio time signal.

Time and tide wait for no man. But a marvel among measuring devices takes 37 measured facts set into its mechanism to predict years ahead the height and time of day of all tides for every port of the world. Mathematically minded, this device turns the measures of yesterday in prophecy for to-morrow to guide ships unbuilt on voyages undreamed.

Sound and radio are used to measure ocean depths, the thickness of glaciers, or the height of the radio ceiling of our air. Radio impulses go up with the speed of light and echo back from the magnetic layer of our atmosphere over a hundred miles up. By timing the echo we measure the ceiling, which may rise 50 miles in a magnetic storm. Echo times indicate that some radio echoes come from far beyond the moon. Sound waves are sent to sea bottoms and their echoes timed to measure ocean depths for marine charts in aid of navigation. By similar means the thickness of glaciers is measured by timed echoes through the glacier from the rock beyond.

Measures are tools of discovery. One bright story tells how the mystery of the breeding place of the Atlantic eel was solved by measuring. Out from the rivers swarm the eels every autumn to be lost to sight at sea. Where they bred, no one knew. Catches of eels were measured from millions of square miles. Measuring their way in all directions along lines of shortening eel lengths to the size of the baby eels, all trails led to the Sargasso Sea, which proved to be the

cradle waters of their infancy,—a mystery solved by measuring lengths.

Nature does not annihilate her past. She leaves a record in which we may read history through measurements. Tree rings thousands of years old reveal the growing weather of climatic history of ancient times, year by year. How the rise and fall in tree growth in 11-year rhythms were matched by similar rise and fall in the number of suspects is an interesting story, for phenomena which vary in parallel reveal cause and effect connections of profound importance.

Measures are great teachers, reducing error, diffusing truth. They dispel error by teaching, for example, that a pint is not a pound the world around, and never was anywhere; in America, that the needle is not true to the pole; that the so-called "solar constant" is variable; and there are no fixed stars. Measures tell how much a pint of a liquid weighs, by how many degrees the needle wanders from true north, how the solar constant (sun's radiation) varies, and how many miles a second the fixed stars are moving.

Measures teach truth with vividness. We all conceive the atom as very small, but we learn how small an atom really is when 30 methods of measuring them tell us that a billion atoms in a line measure an inch, or more startling still that if all atoms in a thimbleful became tennis balls they would cover the United States hundreds of feet deep.

Again, we all have some idea of the Gulf Stream, but how vastly more vivid it becomes when measures tell us that the volume flow of the Gulf Stream off Miami is 14 cubic miles an hour, or equal to 1,000 Mississippi Rivers in one.

Men who measure do not lack devotion. Countless cases might be recalled of courage, suffering, even death, among the army of measurers who in laboratory, observatory, or in other parts of the world gather measured descriptions of nature and her phenomena. Galileo, "the father of laboratory science," was its first victim. In the great Tokyo earthquake of 1923 the Japanese experts stuck to their work of measuring the earth movements while outside they beheld their own homes going down in ruins and up in flames, a devotion which gave the world its most accurate scientific narrative in earthquake annals.

The engineer puts measures to work in skyscrapers, bridges, and other structures. Measures flow through his pencil to scale drawings, making each point a location, each line a length to be translated into steel or stone, matching measured strength for measured stress. By means of measures of strength and dimension the engineer builds his dream of stability into structure and the architect actualizes his dream of beauty. When the cathedral stands finished, strong and beautiful, we forget the measures, but they remain forever the strength and beauty of the cathedral.

—*Commercial Standards Monthly*

Arcing Air-Break Switches

Most of us are familiar with advertisements of specifics, or remedies, which are heralded as panaceas for a rather inclusive list of bodily ills. These nostrums more often than not prove to be a sort of apprentice "Jack-of-all-trades," and of little value for any definite ailment. Their purveyors are likely to extol the virtues of the products to an extent that it is not warranted by the results obtained from using them. And there is always the chance that the remedies will be misapplied—that is, employed for purposes other than those for which they were intended.

Similarly, experience with the ordinary so-called "safety switch," as used in industrial plants, would seem to indicate that in some cases, at least this excellent device is considered to be a cure-all for a wide variety of electrical troubles, regardless of the conditions under which it is installed and operated. Years ago, workers were constantly exposed to the hazards of burns and shocks from open knife-switches — particularly from those used for controlling motor circuits. Burns from excessive arcing when opening or closing the switches, and shocks resulting from direct bodily contact with the switches, or from indirect contact with them through tools or materials (such as metal pipes and rods in the hands of workers) were the most common forms of accidental injuries. Then came the inclosed switch. At first, the inclosure consisted merely of a metal or composition cover, and an external operating handle was provided. With various subsequent improvements, and with the addition of interlocking devices, these switches seemed to meet the situation, as far as contact accidents were concerned, during ordinary use and with proper application. Of late, however, a number of accidents have been reported as having taken place during the ordinary operation of so-called safety switches, and from the nature of these occurrences it would seem that the primary causes were poor engineering application and lack of proper maintenance and repair.

Whenever a current of electricity flows through a conductor, it meets with a certain amount of resistance, and in consequence of this, heat is generated. The designers of certain forms of electrical equipment and apparatus such as transmission lines, transformers, rotating machines and their controlling devices, are continually striving to keep this heat element at the lowest possible point. To them it represents loss, or waste of energy. Designers of certain other forms of apparatus (exemplified by the electric furnace and various electrical household devices) are facing the problem from an exactly opposite point of view, inasmuch as they are interested to discover the most efficient means of converting electrical energy into heat energy.

In all such cases we are likely to have our attention centered upon the larger pieces of apparatus—the things that do the work—rather than upon

the controlling and protective devices, such as fuses, switches and relays. To the uninitiated (and their number is legion) the fuse seems to be a simple and altogether insignificant part of an electrical installation. Simple it is—consisting merely of an inclosed strip of metal or piece of wire mounted in such a way that it may be conveniently inserted in the circuit—but it is by no means insignificant. In fact it is the watch dog, located out in front to prevent the entrance of excessive currents which may damage the apparatus or set fire to the property.

In like manner, a switch is considered to be merely another simple device, by which a circuit may be closed or opened; and so it is. But here again the importance of the device is not fully evident, and many fail to grasp the significance of the fact that upon the proper functioning of the switch may depend the safety of the apparatus, of other property, and even of life. A switch must comply with certain basic principles well known to the manufacturers, but often little appreciated by the users—especially in industry. The jaws, the blade, and the hinge and its supports must have sufficient carrying capacity to transmit the needed amount of electric current without excessive heating. The various parts must also be aligned so that there will be a close and snug contact, without undue strain on the parts during operation. Arcing and sparking must likewise be kept under control.

The capacity of a switch has an important bearing on its efficiency, and still more on its durability and on the hazards associated with its operation. The permissible current-density for sliding contacts, will range from 70 to 100 amperes per square inch. Thus, a 25-horsepower motor operating at 250 volts and 75 to 80 amperes, would require a switch having a contact area of at least one square inch. If, through an error a switch with contacts having only half a square inch of area were used, it is quite likely that there would be local heating, as well as voltage drop and unsatisfactory service from the motor. Certainly there would be excessive arcing when opening and closing the switch.

A switch that is opened slowly is more likely to arc than one that is opened quickly, and up to a certain point quickening the break not only decreases the likelihood of arcing, but also reduces the size of the flash in case arcing does occur.

Poor engineering application simply means using the wrong tool or machine for a given purpose, and in this case it means using the incorrect size or type of inclosed switch for a given duty on a motor circuit. Motor-control switches for alternating-current circuits are ordinarily rated and sold on an ampere basis. A switch may be made, rated, and sold to meet a certain condition, but there is always the possibility that the condition may be changed. The motor may soon be overloaded continuously; a larger motor may be substituted; or another machine, with or without a motor (as in group drive) may be added, without giving thought to the switch control. Under any of these conditions the current-carrying parts of the switch may be overloaded,

with the result that they will become heated.

When a switch is opened, there is a momentary concentration of current flow in a rapidly diminishing area of the current-carrying parts. This tends to produce an arc—an arc at a switch being caused by intense and rapid heating at the contact points. Every degree that the temperature of the current-carrying parts of a switch is raised above the temperature of the surrounding air, increases the likelihood of arcing. Thus it is that proper engineering application has its influence on the performance and length of service of the switch as well as on the safety of those who operate it.

Excessive arcing is likewise sure to occur if the component parts of a switch are not kept in perfect alignment. Suppose, for example, that the hinge of the blade has become worn and loosened. There then will be a corresponding amount of side play when the switch is opened and closed. The blade will neither enter nor leave the jaws directly and positively, and therefore will make arcing contacts.

Every time there is arcing at switch contacts there is burning, which means that a portion of the switch material is destroyed. In addition, there is likely to be pitting, and deposition of burned material. This will increase the resistance between the contacts, lower the efficiency of the switch as a whole, and increase the likelihood of arcing under less severe conditions. The trouble then becomes cumulative.

An arcing switch that is operated by hand may be the direct cause of severe injuries in the form of burns. Unless a magnet or a strong current of air is present, the flame from the arc will travel upward. Anyone operating an exposed knife-switch necessarily places his hand above the starting point of the arc. As the switch is opened, the hand travels away from the arc and the danger is thus somewhat reduced. When closing the switch, however, the reverse is true, because the hand is then travelling toward the flame. Even inclosed switches are not entirely safe in this respect, because burns have resulted when the arc flames have blown the covers open, or have otherwise escaped from the confines of the inclosing boxes.

This brings us to one other source of danger from arcing switches. In places where explosive gases or dusts are present or are likely to be generated, great care is usually exercised to exclude all possible igniting agents. An electric switch is considered to be a source of ignition (because of the possibility of arcing) and is rightly banned. This may work a hardship, or at least cause inconvenience, if explosion-proof electric motors, or electric lamps in vapor-proof globes are employed. It would seem, then, that an explosion-proof switch is in demand.

Such a switch would be one that could be operated without danger of igniting an explosive mixture in the room in which it is located, and the ideal one for this purpose would be one that would operate without the least trace of arcing or sparking. This ideal is hardly likely to be attained, however, and the next best thing is to design a switch that will

operate with a minimum of arcing or sparking, and to surround it with a box that will prevent any flame (resulting from a possible explosion of gas or dust within the box) from reaching and igniting a similar explosive mixture outside the box.

The introduction of electricity into coal mines brought with it the possibility of igniting methane and coal dust, and this caused the Federal Government, through the Bureau of Mines, to study the subject. As a result of its investigation, the Bureau is now prepared to test electrical apparatus designed for use in gassy or dusty coal mines, and if the apparatus meets with the Bureau's requirements it is listed as "permissible"—that is, it is considered safe for use in those places. For the most part, motors and their controlling devices are made "permissible" by surrounding them with metal inclosures having deep flanges or grids, by which explosive flames within the inclosures are cooled below the ignition point, or are prevented from reaching the outside atmosphere.

An explosive mixture of methane and air can be ignited at from 550° to 750° Centigrade, if the duration of the exposure and the volume of the heating or igniting agent are sufficient. An electric spark has a temperature considerably in excess of this, but a small or thin spark may be harmless, whereas a fat or large spark of no greater temperature may ignite a suitable air-methane mixture.

Under like conditions of voltage, current, and quickness of break, a double-break switch will cause a spark one-half as long as a single-break switch, and a four-break switch will cause a spark only one-fourth as long as a single-break switch. It would seem, then, that a quick-acting four-break switch, to keep the sparking as low as possible, both as to duration and volume and a flame-proof inclosure, are the prime essentials for safety in connection with switches for use under gassy or dusty conditions.

Excessive arcing—that is, arcing which assumes the proportions of a "switch explosion" — is becoming more and more common in connection with motor circuits that are sometimes operated under abnormal conditions. When such explosions occur, the persons operating the switches often sustain severe injuries in the form of burns of the neck, hands, face and arms. The situation has become so serious that the authorities in certain states are now requiring that *inclosed switches be rated on a horse-power basis*, when replacements or new installations are made. This applies on such services as feeders, sub-feeders and branch circuits supplying motor installations, where the capacity of the switches and fuses does not exceed 200 amperes and the operating potential is from 300 to 600 volts. The Underwriters' Laboratories have tested a limited number of switches on this basis and are now listing them as approved appliances. It is felt that properly designed quick-break, little-or-no-arcing, inclosed switches, when installed on a horse-power-rating basis, will give better performance and longer life, and will eliminate explosions and consequent injuries.—*The Travellers Standard.*

HYDRO NEWS ITEMS

Eastern Ontario System

A request has been received from the Village of Morrisburg for estimates on the delivery of 100 to 200 h.p. to this village.

* * * *

The Westport distribution system was made alive on November 14th. Power is supplied from the Forfar station of the Commission.

* * * *

Power was turned on in the village of Bath on November 4, 1931. The Napanee Public Utilities Commission has constructed the distribution system for the village.

* * * *

At the request of the municipality data were submitted in connection with sale of the Newburg local distribution system, but to date no further action has been taken.

* * * *

At the request of the municipality documents dealing with the proposed sale of the electric and water utilities were forwarded to the Municipal Council of the town of Cobourg for consideration.

* * * *

Since July 1st, 1930, the Village of Iroquois has been supplied at times with temporary power as a customer of the Iroquois Rural Power District. Owing to the water driven generating plant of the village not having capacity to supply present requirements the village has requested estimates on the delivery of 100 to 300 h.p. from the Commission.

* * * *

The Commission has terminated its interchange of power arrangement with the Peterborough Cereal Company, and the Peterborough Public Utilities Commission is now supplying all of the power to this Company. The Company has recently installed additional electric ovens with a capacity of approximately 450 h.p.

Fifty years ago, according to *The Electrician* of May 15, 1880, the gas interests were already showing signs of alarm at the development of electricity as an illuminant, and anti-electric propaganda was beginning. A statement by "Gas and Water Engineering" was quoted to the effect that doctors were prophesying that the electric light would eventually destroy the eyesight, one medical man claiming to have been blind for three days in consequence of having attended a concert in San Francisco in a hall supplied with the electric light. (As this was before the days of Prohibition, it was probably a smoking concert.)

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

New Home of the Oshawa Public Utilities Commission

WEDNESDAY, December 2nd, will always be a red letter day in the records of the Oshawa Public Utilities Commission, for on the evening of that day the new office building was officially opened by the Honourable J. R. Cooke, Chairman of the Hydro-Electric Power Commission of Ontario. Preceding the opening of the building the Local Commission entertained officials of the Hydro-Electric Power Commission of Ontario, members of the City Council and other public bodies, at a dinner given in the Hotel Genosha. The opening ceremonies were brief, Hon. Mr. Cooke unveiling a tablet in the building recording the event, after which a public meeting was held in the Auditorium of Centre Street Public School. Here there were addresses by Hon. Mr. Cooke, Rt. Hon. Arthur Meighen, Commissioner and Dr. F. A. Gaby, Chief Engineer, Hydro-Electric Power Commission of Ontario, Hon. W. E. N. Sinclair, Mayor Ernest Marks, members of the Local Commission and others.

The building is designed to house the scattered members of the Commission's staff under one roof, and in it will be found all departments of the combined Electric and Water Utilities many of whom were previously accommodated in rented quarters in different parts of the city. The new building is the first of a proposed group of municipal buildings which it is hoped will some day flank Memorial Park, and is of modern fireproof construction throughout, the exterior walls being of brown pressed brick with white artificial stone trim.

The main entrance opens through a revolving door directly on to the public concourse, at the rear of which is the counter where will be found the various departments having contact with the public. Adjoining are the Manager's and Secretary's offices and working space for the office staff.

On the second floor provision is made for drafting room, the Water Superintendent's office, the electric meter storage and repair room and the Commission's Board Room. The basement will house the activities of

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the Outside Department of the Water Utilities, as also the heating system and the electrical controls.

The heating system is the most modern of its kind. The large undivided space of the main floor is heated entirely by motor-driven heating and ventilating cabinets. Fresh air is drawn into the building and the system can at will be operated either for heating in Winter or cooling in Summer. The second floor and the private offices on the main floor are heated by concealed wall heaters. By the system no valuable floor space is taken up by radiators. The temperature within the building is controlled by electrically-operated thermostats. Two boilers operating under forced draft and thermostatically controlled to maintain steam pressure between certain limits, supply heat for the system.

The electric wiring is planned to provide for every conceivable need within the building.

The Oshawa Public Utilities Commission is the successor of the original Water Commission, which was organized in 1904. The Water Commission functioned as such until the Council negotiated with the Hydro-Electric Power Commission of Ontario for the purchase of the gas and electric utilities during 1928 and 1929. Following this move the first Public Utilities Commission was elected on January 6, 1930, which took over the operation of the water, gas and electric departments. On March 21, 1931, the citizens authorized the sale of the gas utility to the Ontario Shore Gas Company on a 50-year franchise basis. Under the Public Utilities Commission, many important improvements have been made in the water and electric systems, as well as substantial reductions in the rates charged the consumers. All improvements, including the new building, have been financed by the Commission, no part of the expenditures being connected with the tax rate of the City. The Public Utilities Commission, in addition to its other duties, operates the Oshawa Rural District on behalf of the Hydro-Electric Power Commission of Ontario.

The members of the Oshawa Public Utilities Commission have all had a place in the public life of the City. Ex-Mayor John Stacey is Chairman of the Commission. The other members are Ex-Mayor F. L. Mason, Ex-Mayor Robert Preston, George Allchin, a former member of the City Council, and Mayor Ernest Marks. The operation of the utilities is under the direction of Charles T. Barnes, Manager, A. E. Colvin, Superintendent of Waterworks, and George F. Shreve, Secretary-Treasurer.

New Oshawa Public Utilities Commission Building.

Left Turn Motor Vehicle Signals

By Geo. E. Cousins, Illumination Laboratory, H.E.P.C. of Ont.

MANY of the accidents attending the use of motor vehicles can be eliminated if one driver is informed as to what another driver intends to do. This is particularly true in these days of high speed travel, when cars follow one another closely and an unexpected move by one driver may seriously endanger occupants of following or approaching cars. The Department of Highways of Ontario has been active in adopting means to promote safety on the highways of the Province, and to this end has adopted the following amendment to the Highway Traffic Act.

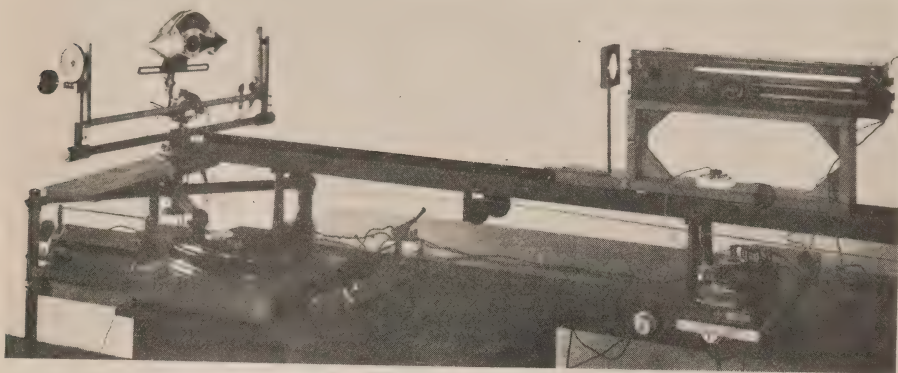
> "The driver or operator of a vehicle upon a highway before turning to the left from a direct line shall first see that such movement can be made in safety, and if the operation of any other vehicle may be affected by such movement shall give a signal plainly visible to the driver or operator of such vehicle of the intention to make such movement."

As testing agents for the Department the illumination laboratory was instructed to study the requirements of electrical signals that would merit official approval, to formulate specifications for test and to standardize the details of the test.

The arrow head seemed the most logical character to indicate direction and some modification of it was adopted by most of those submitting signals. The luminous area must be sufficiently large and the light from it diffused so that the form of the character will be discernible from a distance sufficient to make certain the correct interpretation of the signal in time to enable a driver to act according to its message. The intensity of the light from the signal must be high enough to catch the attention of following or approaching drivers. Cognizance was also taken of the greater attracting power of flashing or moving signals as compared to steady burning or stationary ones. Signals that depend upon the reading of words or letters are not approved.

An assortment of nine signals was available for experimentation and in addition an experimental model was constructed that could be varied in luminous area and candlepower. With these it was possible to observe the merits of different features under different combinations of traffic conditions.

An approved signal must produce at least two candlepower of red light measured on the signal axis, if of the steady burning, stationary type; or one candlepower if the signal combines motion or flashing. Over an angular spread of 30° to the right and 30° to the left of the axis, on a horizontal plane and also on a plane inclined 15° from the horizontal and over the same spread the candlepower shall not be less than 0.5. The signal or signals shall also show an amber or yellow light toward the front of the car. The purpose of the different



Left-turn signal under test.

color is that it will not be confused with a tail light or reflex reflector on the rear of a vehicle ahead. The original group of signals was submitted before the specifications were drawn up and only one proved satisfactory. Since then others have been improved and have been found to comply with the requirements of the specifications. It is important that signals mounted on the front of a car be kept away from close proximity to the head lamps so that the brightness of the headlights at night will not obscure the signals.

The switches for operating the signals must have a manual operation whether or not they may be automatic in addition. The best combination is one that is set in operation manually and opened automatically.

Only the left-turn signals are included in the act but some of the signals are put up in sets including right-turn indications as well.

The addition of turn signals to a car will contribute greatly to the safety and convenience of driving, more particularly during cold weather when one is disinclined to open the window to extend the arm and hand although this complies with the requirement of the amendment to the Highway Traffic Act.

Electric Lighting in the Eighties.

The Town of Pembroke, Ontario, claims to be the first municipality in Canada to have an electric system for street and commercial lighting. The lighting was accomplished by the use of arc lamps operated on a series system, those for store lighting being on the same circuits as the street lights. The high voltage series wires were carried into the building whereever a lamp was required. This was in 1884, long before the invention of safety rules for electric wiring or the existence of the Electrical Inspection Department.

The inauguration of this new kind of lighting was an important event in the lives of the citizens. Joseph Leahy, Washington, D.C., a former Alumette Island boy, was in Pembroke on that evening and gives the story of his impressions, at that time, in *The Pembroke Standard-Observer*. Mr. Leahy writes :

"I was carried back a few years, to a day I had taken a load of cordwood from the Culbute over to Thos. Murray's beautiful house 'up on the hill'. I lingered around until it was almost dark, wandered into T. W. Murray's store, where many people were gathered and an air of excitement seemed to pervade the scene. I inquired the cause and was told that W. B. McAlister was 'trying to get a new-fangled lamp, called "Lektricity" (wow, what a word that was) into town and this one—a large framework affair hanging in the middle of the store—is the first put out, and they are going to light it so people can see what it is—been telling people it was brighter than any coal-oil lamp—the idea?' I looked about the store at all the oil lamps, about 15 or 20 feet apart, and thought it couldn't be possible anything would be brighter. The big arc spluttered, roared and flashed—a brilliancy my wildest flights of imagination had never pictured, and the surroundings were so bright that the poor old oil lamps were barely discernible.

"When I got home, bubbling over with the exciting story of 'the big hanging lamp with two round iron sticks, like big lead pencils, instead of wicks (the carbons) and without any coal oil or candle grease or anything but a big noise, a light brighter than the sun—so bright that the lights of the oil lamps on the walls looked like a lot of little yellow spots!' There was very little comment, but the understanding looks exchanged by the older members of my audience clearly indicated to me that not only my veracity, but my sanity as well were under suspicion, and for a few days I was always kept in sight—possibly in fear of becoming dangerous. A few days later my story was verified by some of the older neighbors, and suspicion was lifted: my dearest friend, with whom I was living at the time, D. J. Kennedy, saying, 'by George, the boy was right after all, and we thought when he came home with what seemed a foolish dream, that he had suddenly gone crazy'."

Radio Interference

VI

Summary

THIS summary is the sixth and last of a series of articles on the subject of "Radio Interference" prepared by our Laboratories for the purpose of explaining the fundamental facts, theories and limitations in regard to the nature, sources and suppression of interference.

The most important points in the five preceding articles,—appearing in the *Bulletin*, issues of May, June, September, October and November, respectively,—are gathered together in the following paragraphs, and given under the numbering of the articles in which they have been more fully explained.

I

Radio Interference is not a matter of the wave form of radiation reaching the antenna but rather of the audio wave form produced by the receiver from such radiations.

Radio interference may be either periodic vibrations, simple or complex, or non-periodic waves: most serious interference is of the latter type.

It is interference, not so much by virtue of the wave form as due to its persistence when not wanted.

It may not be possible in present day receivers to make the desired separation of interference from broadcast signals. All that may be done with any promise of success just now is to trace the interference to its source, and remove the cause.

When the cause is found to be a characteristic of some appliance or machine, a suitable filter should prevent the interference from being carried out along the supply circuits.

The interference may be due to atmospherics, however, the source being beyond human reach and control: an improvement in conditions may be brought about by the use of short indoor antennae.

II

The resonant receiver circuits are responsive to radiated sudden impulses which start oscillations at the frequency at which the circuits are tuned: these oscillations, however, are damped out rapidly.

The sudden impulses are caused by sudden changes in magnitude of voltage or current in any electric circuit, or in the atmosphere,—turning on a light, or a flash of lightning.

If the interference be of short duration, and not frequently repeated, it is not usually considered very serious. The interference that persists seems to be the more annoying.

Many electrical appliances, while in operation, cause a series of sudden changes in the voltage or current of the supply circuits, and account for a great deal of the more serious interference experienced.

A list of some appliances which may cause interference may be found in the June issue.

III

Practically any means of locating interference sources seems justifiable.

The Radio Branch, Department of Marine, employ a number of men and have twenty-four specially equipped cars locating sources of interference in the many cities and towns throughout the Dominion. These men are ready on call to trace down any source of interference reported.

Some methods of locating interference may easily be applied by any broadcast listener without special equipment whereas other methods require very delicate measuring instruments.

Interference may be caused by household appliances in which case the broadcast listener may be able to aid in locating the source of trouble.

It may be due to industrial appliances, however, and it may then be necessary to leave the matter in the hands of the Department of Marine.

Surge traps may be applied to confine the interference to certain parts of the circuits and thus prevent it from spreading along supply lines and other circuits.

IV

Interference may radiate from power lines and be annoying in the neighborhood of such lines when alive, or may be carried by other lines which are exposed to live lines.

If the receiving aerial be within the magnetic or electrostatic fields of a power line, the interference may be only at normal operating frequency and may be prevented by the use of a drain coil across the receiver from aerial to ground terminals.

Leakage within insulators, or over their surfaces, may cause a type of interference which will travel along lines and radiate from these lines. This type is difficult to trace as it is induced on other lines and thus misleads the searcher.

Interference caused by corona is not usually serious.

The types of interference caused by power lines may be segregated by audible tests, oscillograph tests, and interference strength measurements.

V

The broadcast listener should first endeavour to locate the source by testing his own appliances. If not successful, he should give as comprehensive a report as possible to the Radio Branch, Department of Marine, stating the nature of the interference and what tests he has made.

In many cities, the level of signal strength has been found much lower than local interference may reasonably be expected to be. There is an irriducible level of interference which must be taken as a practical fact, *i.e.*, elevators, street cars, etc.

Many engineers feel that receivers are being over-advertised as to distance range and that the public expect better performance against interference than is reasonable.

In recommending a receiver, the salesman should take into account the locality in which it is to operate, and consider the probable interference level.

When interference is experienced, there should be the closest co-operation between the broadcast listener, the power companies and the Radio Branch, Department of Marine, at Ottawa.

— *F. K. D.*

Some Applications of Hydro-Electric Power in the Development of the Tobacco Industry

By H. D. Rothwell, Assistant Engineer, Municipal Engineering Dept., H.E.P.C. of Ont.

NORFOLK and, in a smaller measure, parts of Elgin and Oxford counties have in the past few years seen a transformation and development from an agricultural point of view having scarcely a parallel in the past decade in eastern Canada, and which has all been brought about by the culture of Virginia bright-leaf tobacco. This section of country, in which are situated the town of Simcoe and the villages of Delhi, Lynedoch, St. Williams and Vittoria, has sometimes been referred to as the "blow sand country". Anyone having seen it ten years ago with its dilapidated farm buildings and abandoned farms, would be very much surprised to-day on taking a trip through that area to see the enormous development which has taken place. This has all been brought about by the fact that the soil is particularly adapted to the growing of Virginia bright-leaf tobacco, which is used principally in the manufacture of high-grade cigarettes.

The culture of this type of tobacco is considerably different from that employed in the growing of burley and cigar-leaf tobaccos, which may be extensively seen in the county of Essex and in some sections of the Provinces of Quebec and British Columbia. In the cultivation of Virginia bright-leaf tobacco, it is necessary that the soil be of a very light sandy nature, well drained and in a section where the time of growing and development is sufficiently short that the crop may be completely harvested before there is any danger from frost. Norfolk county appears to have all the factors with respect to climate to produce successfully a first-class grade of tobacco and with an acreage sufficient to supply a considerable percentage of our domestic requirements.

In this article it is not proposed to review the various stages of development, but will briefly state that the industry is but a few years old and in that short space of time has grown to a point where in 1931

Entrance to Ontario Government Reforestry Station at St. Williams.

Inside of a greenhouse in early spring with young tobacco plants ready for transplanting.

there were about 23,216 acres of land devoted to this purpose divided into 773 farms, with a production of approximately 21,000,000 pounds having a value in excess of $4,000,000. It must be realized that this is a new industry for this section of the country and produced from soil which formerly yielded but little, and the consequent increase in wealth must have a very marked effect upon the prosperity of the area as well as Canada as a whole.

In the growing of this tobacco, the

Typical greenhouse constructed of wood with sash removed after plants have been transplanted.

Typical view of a tobacco plantation showing kilns and pack barn in the background.

seeds are sewn early in April in greenhouses constructed especially for the purpose, and about the middle of May the young plants are transplanted by machinery in ground that has been previously fertilized and brought under the necessary degree of cultivation. About the middle of July when the plants have reached a fair stage of maturity, the tops are cut off, and following this, the suckers which grow between the leaves and the stock are pruned out so that the maximum growth for the balance of the season may be extended to the leaves only. In the latter part of August or early in September, depending upon the season, the plants are cut and placed in specially built kilns where they are subject to a special heat-treating process which consists of dehydration and certain chemical changes. The leaves when first placed in the kiln, are quite green, and are transformed to a bright yellow when the curing process is completed.

The engineers of the Hydro-Electric Power Commission of Ontario during the past season have made a preliminary investigation concerning the uses of Hydro-electric power in the development of this important and growing industry. Their investigations show that electric power may be used advantageously by the grower of tobacco in a number of ways, the principal ones of which are as follows:

1. Curing.
2. Water pumping.
3. Electric lighting.
4. Special electric lights for color grading.
5. Air circulation within the kiln.
6. Humidity.

It is along these lines that a special study has been made.

1. CURING

The kilns used for the curing of this type of tobacco are small wooden

Cutting tobacco during harvest.

buildings approximately 22 feet long, 18 feet wide and about 15 feet high, usually constructed of matched lumber nailed to a frame work and lined with heavy tar or building paper. The building is placed on a concrete foundation which extends approximately 3 feet above the ground. Situated in two corners of the building are especially constructed warm-air furnaces which are made so that either wood or coal may be burned. From these furnaces the flue gasses are conducted back and forth across the building several times for the purpose of radiating as much heat as possible. The two flues finally come together at the rear of the building and connect to a common stack. The furnaces in question

Arrangement of kilns on a typical plantation.

Filling the kiln with tobacco before curing.

are in all cases fired from the outside of the building through a hole in the foundation, and in some cases are equipped with special vents whereby outside air may be constantly drawn over the heated parts of the furnaces and delivered to the inside. However, this method is not generally employed, but any air required is admitted through portholes constructed in the building foundation. The kiln is constructed in such a manner that when the furnaces are in operation, a constant flow of air enters at the portholes and after being heated, rises to the top and is discharged through special ventilators.

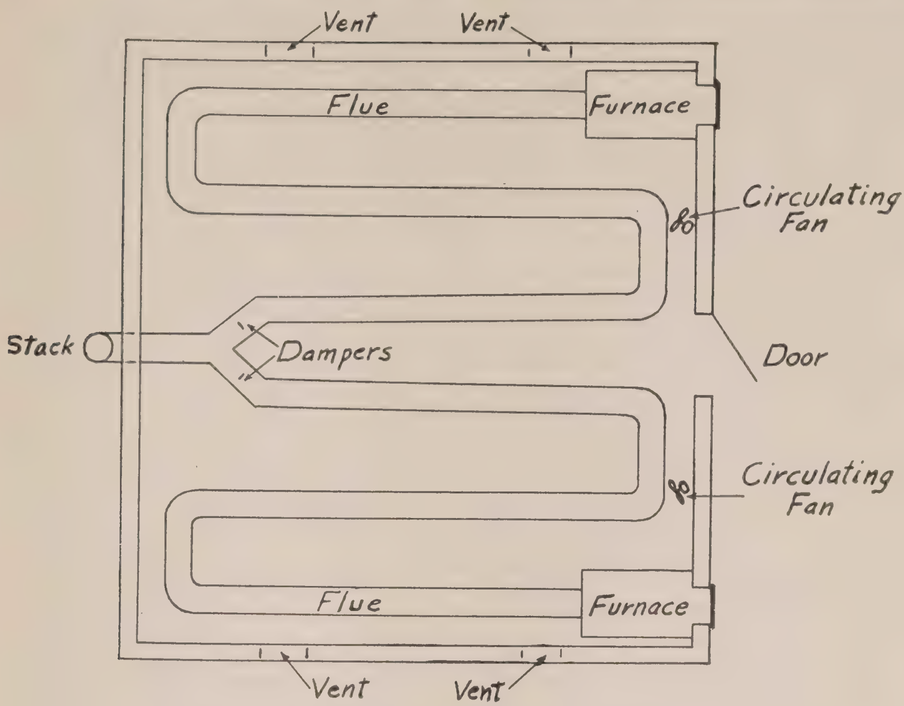
The tobacco, after it has been cut, is placed on special sticks which hold approximately five plants, and by means of these sticks, it is packed in and supported in the kiln until the entire building is full with the exception of a space about five feet in height from the ground. The usual kiln holds between 6,000 and 7,000 plants of an average size. Once the kiln is properly filled, fires are started and the "curing" commenced. For the first day the temperature is raised approximately 10° Fahrenheit above the prevailing temperature outside, after which it is gradually raised from time to time as the curing process advances. This is determined by the curer who is in constant attendance and directs the operations throughout the twenty-four hours. It might be mentioned at this point, that the curer usually has charge of approximately six kilns and not only looks after the temperatures and the general matters pertaining to curing, but is also required to attend the firing of

each kiln, being on duty twenty-four hours per day throughout the period, which at times may last from four to six weeks.

We are informed that the present methods of curing have been brought largely from the states of West Virginia and North Carolina where a similar procedure has been conducted for probably 150 years. It is natural that the methods employed there should be continued here, especially since almost all the curers are imported each season from these states for this particular work.

There are constructed at this time over 4,000 kilns which consume, if wood is used, between 20,000 and 30,000 cords per annum, which would indicate that some other type of fuel must be used on account of the depletion of the supply. In considering this problem, it appeared that the use of forced-draft blowers, thermostatically controlled, would not only be of great assistance to the curer in maintaining the temperature required within the kiln, but would also enable the curer to introduce probably cheaper fuels such as small sizes of anthracite coal or coke breeze. The experiments conducted during the past season consisted of attaching two blowers supplied by the Canadian General Electric Company, Limited, controlled by a thermostat manufactured by the Minneapolis-Honeywell Company. The exhaust from each blower was conducted by means of a six-inch pipe to the ash pit of the furnace and during most of the experiments coke breeze was used, which we believe is the cheapest type of fuel obtainable at this time in

Interior view of a kiln showing method of heat distribution and the arrangement of the tobacco for curing.



Floor Plan of Tobacco Kiln showing location of Circulating Fans

Fig. 1

Canada. The success with this equipment may be graphically seen in figure 2, which gives a history of the temperatures within the kiln as recorded by a graphic recording thermometer, both from a hand-fired kiln as well as one that was thermostatically controlled, having electrically driven forced draft blowers and using coke breeze. It will at once be seen from this curve that the variations in temperature are very much less in the kiln that was thermostatically controlled than in the hand-fired. Furthermore, during the entire test, the curer did not at any time look after the fires, but devoted his time to the regulation of the thermostats to obtain the temperature which he desired over any given period, and to matters pertaining to the curing in general.

Briefly, the results from this show that unskilled labor may be secured to fire the furnaces when operated under the forced-draft system using the cheapest types of fuel and all that remains for the curer to do is to determine the temperatures. The economy at this point would indicate that the curer would be able to look after a greater number of kilns with firemen employed to take care of the other requirements, which

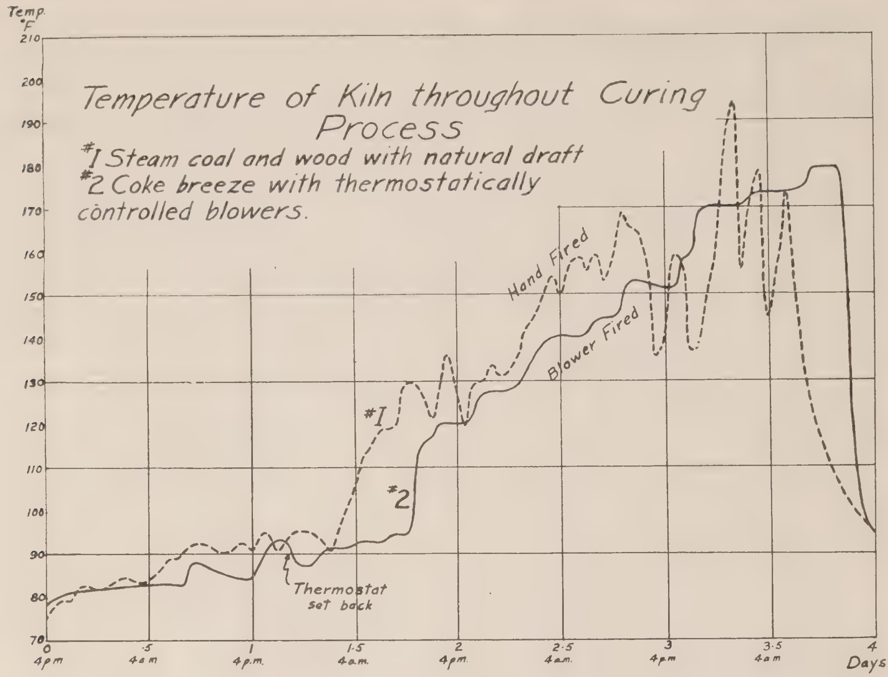


Fig. 2—Curves showing the temperatures maintained within the kiln by present hand fired methods and also with automatic electrical control.

would tend to a higher grade of product with less labor costs.

In the test kiln, it might be mentioned that for the burning of coke breeze, we were loaned a special set of grates by the York Engineering Company of Toronto, which are especially adapted to this type of fuel, and which are very necessary to prevent the fuel passing through the grates into the ashpit. The ashpit, during the entire operation was tightly sealed and was not used in any way, as the clinker was all removed through the fire door.

It is expected that with the use of this automatic electrical equipment, a higher grade of tobacco may reasonably be expected at a cost considerably less than with the present methods and with a power consumption which included extensive lighting around the kilns of approximately 43 kilowatt-hours for each kiln. This of course would be somewhat reduced in actual practice as an excess of lighting was used during the test.

2. Water Pumping

The use of water when the young plants are in the greenhouses is very extensive and the supply must be thoroughly reliable as the plants must be watered at very frequent intervals, especially if the weather happens to be warm at that season of the year. This pumping in the past has largely been accomplished by the use of small gasoline engine-driven pumps, and the results obtained in many instances have not met with

the complete satisfaction of the growers. This condition has been called to the attention of the Commission for some time past and many miles of rural lines have been constructed for the purpose of supplying service to small automatic water pumping systems.

In this connection we might point out that one large company situated in this area, was compelled to employ the services of a mechanic throughout the season to take care of its gasoline engine equipment required to pump water, which meant a considerable expense to the company, as well as a source of annoyance to the grower.

3. Electric Lighting

Since the curing of tobacco is conducted throughout twenty-four hours of the day, it is advantageous to the curer to have lights both within and without the kiln in order that complete operations may be viewed at any time, and also to eliminate the use of oil lanterns which are carried into the kilns for the purpose of reading temperatures during the night. The use of electric lights would unquestionably reduce the fire hazard, as at certain stages during the process of curing, the tobacco becomes dried out and is extremely inflammable. If a fire does occur there is a very remote possibility of extinguishing it.

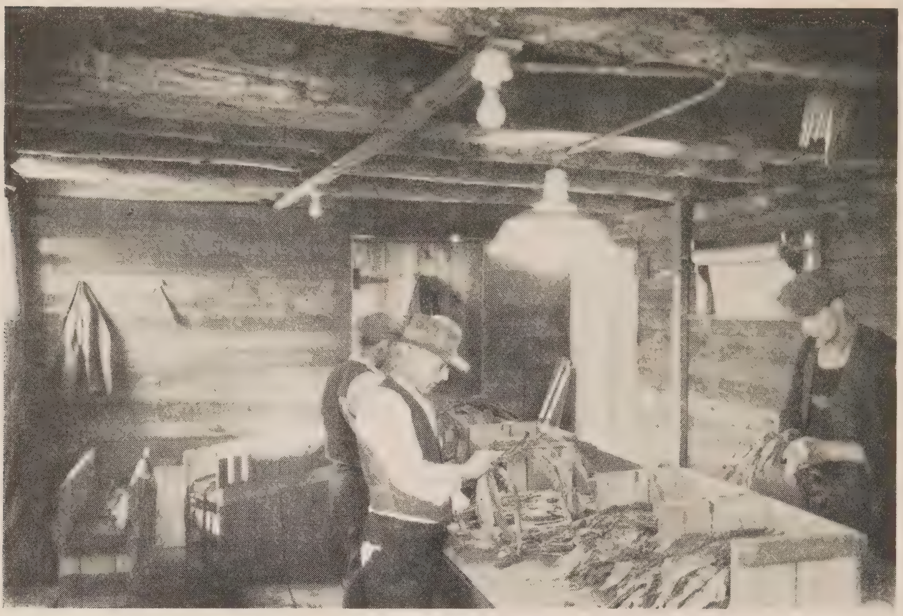
There is also another important feature which cannot be overlooked, namely, that the tobacco after the curing process is completed, is usually removed from the kilns in the early hours of the morning when the temperature and humidity conditions are such that the tobacco is "in case", (that is, the leaves contain sufficient moisture to prevent breaking when handled.) It has been found that electric lights with the proper characteristics facilitate this work to a very great degree.

4. Special Electric Lights for Color Grading

After the harvesting season is completed, it is necessary that the tobacco be stripped from the stocks, graded and packed in bales according to a selection by color. This has been accomplished usually by the use of north light and with varying degrees of success when cloudy or dark days appear. In consultation with the engineers of the Canadian General Electric Company, Limited, a special lamp was produced which gives light having a color which approximates pure sunlight. A number of these lamps have been installed in the grading and stipping rooms in the district with a remarkable degree of success. It may be expected that their use will undoubtedly become general as time goes on, and especially so if the Canadian grower is required to grade tobacco suitable for the English market where a number of color grades are required and great care in the selection of each leaf is necessary. It is interesting to note that with the use of artificial sunlight, the grading operations may be conducted at any time of the day or night with an equal degree of success, which should be of great assistance during the rush season.

5. Air Circulation

Upon investigating the temperatures in the lower part of the kiln, it



Grading tobacco by use of artificial sun lamp developed for this purpose.

was found that a very great variation existed, in some instances amounting to as much as 31° Fahrenheit at the high temperatures and approximately 10° during the low temperature periods. It was, therefore, decided to install two ordinary 12-inch, straight-blow, house fans inside the kiln, as indicated in figure 1. These fans were fitted with a special jacket to admit air from the outside of the kiln through the windings of the motor, in order to maintain a safe operating temperature. The fans were operated for the purpose of constantly stirring the air in the section of the kiln where the radiating pipes and furnaces were situated. With the fans operating, the temperature difference between the front and back of the kiln was reduced to less than 3° under the worst atmospheric conditions noted at that time.

This, we believe, offers a very simple solution to an aggravating problem, especially if cold or windy weather is encountered. The expense of this operation is very low compared with the results obtained.

6. Humidity

A study was made of the humidity existing within and without the kiln during the entire process lasting approximately four days, and figure 3 gives the results during that period. It is very evident that after about two days the dehydration or drying-out process is practically completed, and from calculations made, it might be of interest to note that well over a ton of water is removed from one kiln of tobacco during that period. By the removal of this moisture, the tobacco is left in an exceedingly brittle state and must regain part

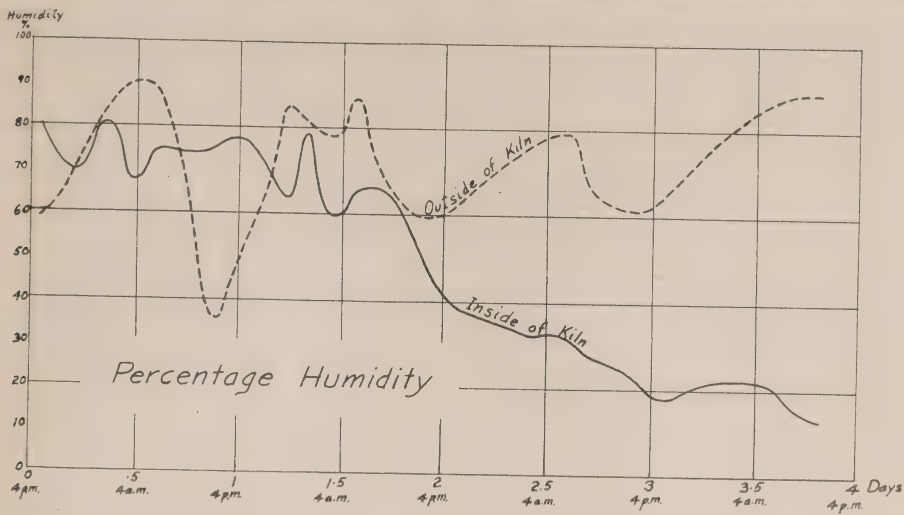
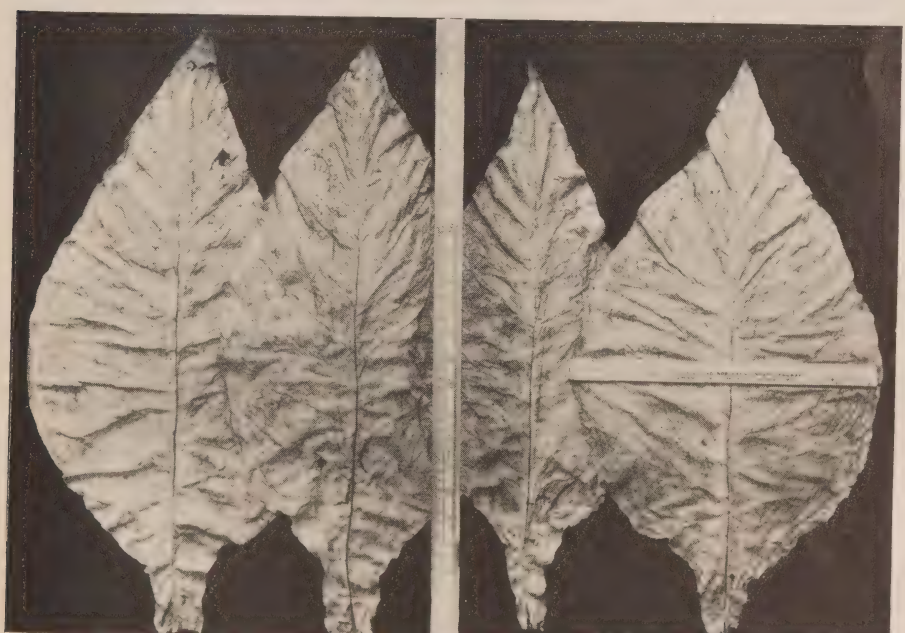


Fig. 3.—Curve showing humidity inside and outside of kiln during process of curing.

of the moisture from the atmosphere before it can be removed from the kiln. At the present time this is accomplished by simply opening the vents and doors of the kiln and allowing the tobacco to regain moisture from the outside atmosphere. This is very readily achieved providing humidity and temperature conditions outside are such



Typical leaves after curing.

that sufficient moisture may be obtained, but there are times when a period of several days is necessary before the regain is sufficient, which will at times cause considerable loss on account of the kiln being tied up. Experiments were conducted with a view of hastening this regain by the introduction of humidity within the kiln itself. Humidifying devices were obtained from the W. J. Westaway Company of Hamilton, but owing to a wrong application of the devices, the results hoped for were not realized, and as this experiment was not undertaken until the last days of the harvest, it was impossible to give it the time deserved.

It is hoped that by a change of method during the coming season, the problem of humidifying or bringing the tobacco artificially into "case" may be worked out. Traction engines, supplying steam to the kilns is practically the only method in use to-day, with an expense all out of proportion to that anticipated by an electrical method.

Conclusion

It would appear that there are a great many uses for the application of Hydro-electric power in the tobacco growing industry as conducted in the County of Norfolk and in probably a greater number of forms than those illustrated in this article. A detailed study should be made and every assistance possible given the grower to show him where electricity may be used to his commercial advantage in the saving of fuel, time and labor.

The writer is of the opinion that if applied science is introduced at this time while the industry is young an instrument will be placed in the hands of the young Canadian who is now eagerly learning the business as well as the many hundreds from the United States who have already settled in this area, to produce not only cheaper tobacco, but, such as will lead the world in quality.

O.M.E.A. — A.M.E.U.

Convention at

Royal York Hotel,

Toronto

January 27, 28 & 29, 1932

Wood Pole Lines at Higher Voltages

Operating Characteristics Over Relatively Long Periods. Nipigon Lines—Thunder Bay System of the Hydro-Electric Power Commission of Ontario

By A. E. Davison, Transmission Engineer, H.E.P.C. of Ont.

DURING the war, organized municipalities of the shipping and industrial districts of Ontario, at the head of navigation of the Great Lakes called upon the Hydro-Electric Power Commission of Ontario for more electric power with the result that the initial hydraulic development of the Nipigon Watershed lying north of Lake Superior was undertaken.

The transmission of some 12,000 horsepower, a distance of 68 miles from this development to the municipal boundaries of the industrial centre of Port Arthur, was a part of this enterprise. The air line was shorter than the transmission distance which was finally adopted, by 18 miles. The economic saving of this shorter route was waived, because of the possibility of industrial and mining developments along the existing transportation routes in the territory, one of which, a pulp mill in the valley of the Nipigon River, was imminent, and because of recognized difficulties of construction and transportation over the shorter route.

The route, figure 1, was through comparatively level, but well wooded and rocky country which was generally well mineralized but had not been so developed, for a total distance of 75 miles, of which 6 miles was a tap line serving an industrial load at Nipigon, as indicated.

At the generating end for a distance of 16 miles, the line was projected through the Nipigon forest reserve, an area of very fine virgin coniferous timber largely on land having good natural drainage but without development or transportation. Following this the line passed through 12 miles of muskeg which had good clay bottom at 6 to 12 feet, and on which there was a heavy growth of 6-inch to 9-inch diameter pulp timber. For the balance of the route, ground conditions varied greatly from level fields which were under cultivation to shifting sands and to mineralized rocks with rough contour, but generally carrying much brule and second growth scattered timber. About 75 per cent. of the route had to be cleared.

A decision had to be made as to type of supporting structures, when steel was practically non-existent for civil purposes, and when fabrication shops had, in many cases, been turned into shell factories. Up to this time, the Commission had always used steel supports for some 1,000 miles of higher voltage lines although wood had been used extensively at the lower voltages.

Attention was called by Austin, who was interested in the manufacture of insulation and in the successful operation of transmission systems generally, to some good operating characteristics of certain types of wood pole construction at

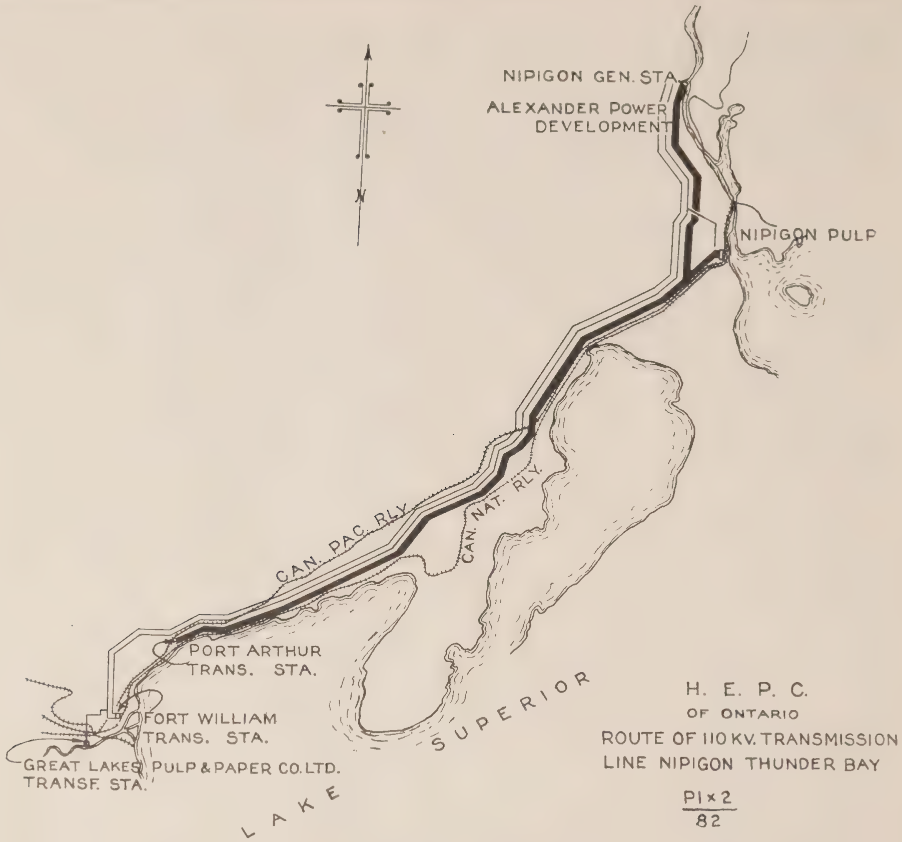


Fig. 1—Route of 110 kv. transmission line, Nipigon to Port Arthur.

higher voltages. Most of the more successful lines were operating in the higher altitudes of west central United States.

A study was made of the availability of this material for the structures and of operating records of lower voltage lines in densely wooded territory as well as of some special features which might be introduced so as to use more effectively the insulating value of the wood itself.

Among other difficulties, lightning, since the line skirted "Thunder Bay", and forest fires, since a number of disastrous fires had occurred in nearby territory, required special attention. The frequency and voltage had already been established at 60 cycles and 110,000 volts (110 kv.), star-connected. It is actually operating at 120 kv.

Only one circuit was to be built for this service for the first four or five years because of economic reasons and because of difficulties in securing labour for civil purposes. At the same time, the service must be reliable because certain pulp and paper processes, grain transfer facilities and more especially municipal water and light stations were quite dependent upon it—momentary shut-

downs would be serious. One or two major outages would almost immediately force duplication or some such drastic and expensive measure, and burdensome expense, at a very trying time in the history of the Province.

This study brought to mind quite prominently many shattered poles due to lightning where sky or grounded guard wires had not been used, and as well the fact that the Commission had not built any lines without ground wire equipment up to that time. If single poles were to be considered then the addition of a ground wire would load up, mechanically, a pole already carrying three phases of No. 0000 A.C.S.R. (economic size) insulated for 110 kv. and a pair of telephone wires. It was observed that numerous double-circuit pole lines operating at 13 kv. to 26 kv. had been successfully carrying six relatively large power wires, three or more lower voltage wires, one or more pairs of telephone wires and in addition, a ground wire, at standard spans of 132 ft. to 165 ft., successfully over long periods—that

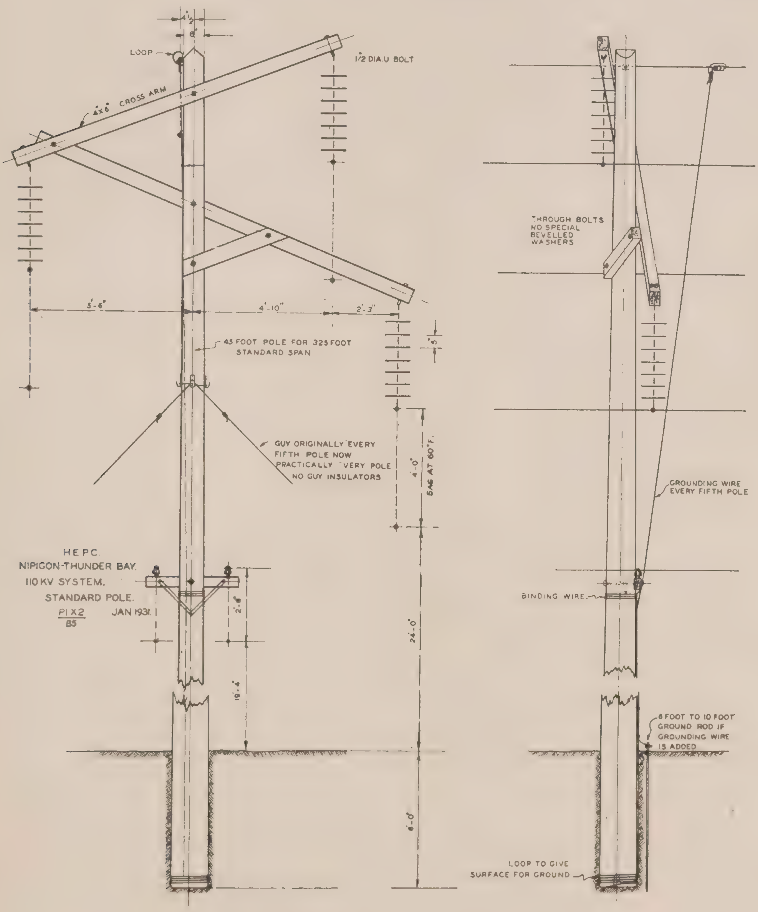


Fig. 2—Standard pole construction.

is, 8 to 10 years, without serious outages. A 110-kv., single-circuit pole top, figure 2, could be designed for 325 ft. spacing, which would not account for greater wind loads than these double-circuit lower voltage lines had been carrying successfully. As a result of this information, it was decided that a sky wire should be added using aerial grounding wires, figure 2, extending from a point on the sky wire about 30 inches from the pole downwards to the pole at about the elevation of the telephone wire crossarm, where it is secured to the pole by three or four turns of binding wire, thence stapled to the pole, to a small coil, which would supply surface area for an electrical ground, at the foot of the pole. These were installed at every fifth pole, 9/32-inch steel conductor being used. Special care was given to the securing of this grounding wire at the top so that it could not get free. A two-bolt guy clamp was used to secure the loop around the ground wire. The free end of the loop was then served to the grounding wire, figure 2. In some cases a half-hitch around the ground wire was used and the free end of half-hitch was secured to ground wire. This connection and the tensions in the grounding wire are important, if greater tensions than are given below are used in the ground wire itself.

Up to the time that consideration was given to this type of construction, there had been very little experience in Ontario maintaining transmission lines through dense forest areas and still less experience in maintaining service when forest fires crossed or burned along a transmission line.

A superintendent of fire-rangers who had much experience in the timbered areas of Ontario, as well as in France on active service, was asked, in order that we might have a mental picture of the problem and of necessary equipment for fire-fighting, what he would do if a fire such as had occurred in the Cobalt area of Northern Ontario only a few months before, were to get started in the area through which the line was projected and provided he had two hundred fire-fighters on the ground equipped, so far as equipment was then available, to fight it. His reply indicated a familiarity with the Liskeard-Cochrane disasters, when he said, "I would get the men out just as far as I could."

With such information confirmed by others, it was decided that a strip 80 feet only in width should be cleared, and in addition that those trees beyond this strip which might fall on the line should be cut down. It did not seem practical to clear a strip across which such forest fires might not be expected to jump.

Because of the forest fire hazard and the length of line which was to operate as a single-circuit for several years, sectionalization switches were installed at four points on the main line and so as to clear the tap line. These were never used until the steel line was available when interswitching was provided through air-break, switches at the mid-point of the main line. At least two forest fires have since actually crossed the line as may be observed by examining the forest in the vicinity. In each case the circuit carried by wood poles continued to operate without an outage

and without the loss of a pole, although one pole had to be stubbed.

The typical structure, figure 2, was generally western cedar with preservative oil wash for the butts as a field coat. All will agree that this structure is not a particularly attractive contribution to the art and that little success may be expected from attempting its use on residential streets. British Columbia fir cross-arms and braces were used.

The minimum distance along a wood path to ground is six feet and the minimum air-gap to grounding wire is five feet two inches when conductors are at rest.

In order to provide sufficient transpositions to co-ordinate this line with existing communication circuits, which were closely paralleled for some 35 miles, and so as to facilitate the operation of the closely coupled service telephone, two-pole dead-ending structures, figure 3, were introduced quite frequently averaging, including corners, railway crossings and switch structures, 2 miles per dead-end structure, of which two only were made of steel because of representations made by railway companies where tracks were crossed. Side guys were attached to every fifth pole at a point slightly above the elevation of the lowest conductor.

The 211,000 cir. mils. A.C.S.R. was pulled to a tension of 2,900 pounds (49 per cent. of elastic limit) when loaded with one-half inch ice and 8 pounds wind. The tensions for the 9/32-inch steel ground wire and for three strands of No. 13 steel

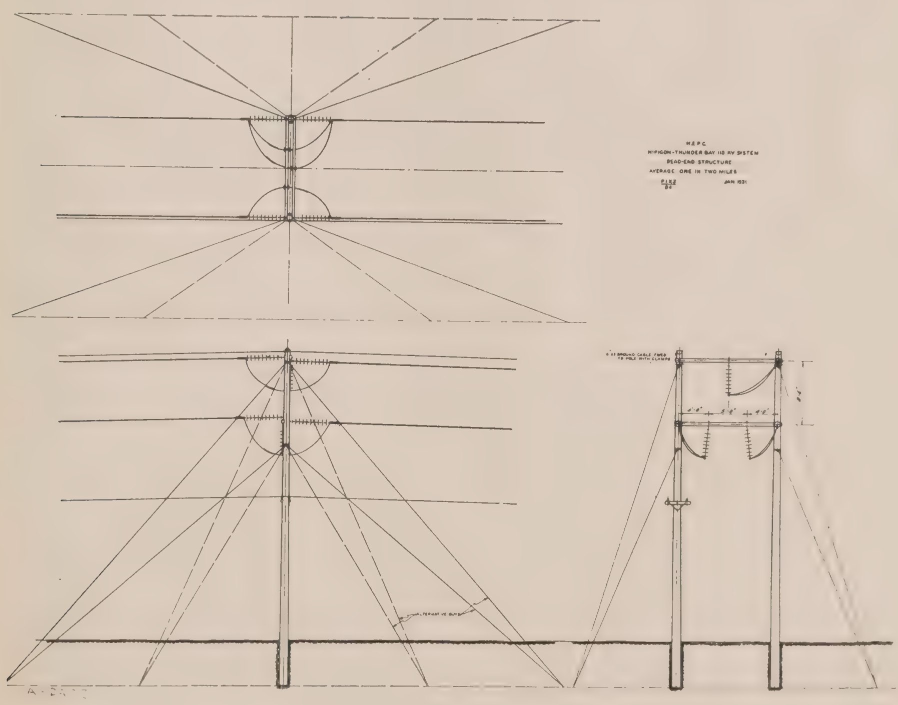


Fig. 3—Dead end structure.

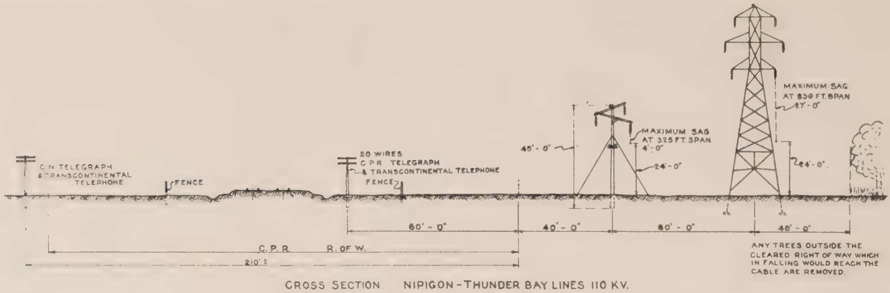


Fig. 4—Cross section of transmission lines paralleling railway and foreign lines.

which was used for the telephone, were for the same assumed loadings, 2,100 and 1,200 pounds respectively.

As the line passed, in part, through undeveloped territory and as outages, if they did occur, would be serious, more than ordinary patrol arrangements were made. Permanent patrol stations were established at four points on the main line and at each of three stations. Four patrolmen's cottages have been built and one purchased. These patrolmen, among other duties, keep brush cleared, test insulators, make telephone repairs and do in addition considerable renewal work on the equipment, such as adding side guys until practically every pole is now side-guyed. They have also protected the poles below the ground line by digging away the earth, shaving or cleaning off the surface rot, then charring the poles and while hot, spraying them well with preservative oil. Keeping the poles clear of ants and wood-peckers accounts for a considerable inspection each year; these troubles are however usually highly localized.

The construction of this line was authorized December 19, 1919. It was put in service December 20, 1920. From that time until September 30, 1924, it operated independently, delivering up to 30,000 horsepower over a distance of 68 miles, at which time it was reinforced, because the demand had increased beyond the rating of the line, by a closely paralleling steel tower supported line of No. 0000 copper. During the first few seasons of operation, this steel tower line operating as a single circuit gave so much trouble on account of lightning that the installation of a ground cable was undertaken, it having been left off largely as an experimental measure. During that time, a matter of 35 months, outages averaged 7.6 per hundred miles per annum, due to lightning only. The outage records due to lightning, since the ground wire was installed, have averaged to the end of 1931, 3.5 per 100 miles per annum. This latter figure takes into account the fact that a second circuit was added to the steel tower line at the beginning of 1930. During the latter part of 1930 some rather restricted clearances on transposition towers were increased. These revisions have improved the operating characteristics of the circuits appreciably. We find that although there were 20 per cent. more storm days in the district during 1931, than there were during the average of the three preceding years, yet there were only

1.5 outages per 100 miles per annum during 1931. The steel supported line is standard double-circuit construction with a standard span of 830 feet with the result that the average height (lower end of middle third of the sag of upper phase) is 55 feet as compared with 33 feet for the wood line. The conductors on the wood pole are insulated with 7 standard suspension units, 5-inch spacing in the suspension position and 9 units for the strain positions. The steel line has 8 and 10 units similarly. It would appear that the steel line removed a standard distance of 60 feet, figure 4, serves as an umbrella for the wood pole line and tends to improve its operating characteristics, if that were possible.

The wood pole line operated without being off load once throughout the four years of single-circuit operation and continued so, excepting when

Fig. 4a—Nipigon-Port Arthur transmission lines—typical construction.

it was automatically tripped on account of overload when a parallel line cleared, until August 15, 1927, when a piece of wire was apparently maliciously thrown over the circuit causing a short-circuit. Following that it continued to operate without interruption because of anything developing within the circuit until May 10, 1929, when there was an automatic trip-out. The line went back into service on first trial but the telephone was grounded. Patrols found a guy wire which had been cut free by an agricultural implement. It was grounding the telephone line and an investigation lead to the statement that a farmer had broken the guy and it had sprung up into the line so as to ground it momentarily.

On February 6, 1931, a gang working on road construction felled a tree which was located on a higher elevation than the line itself, where the line passes through a gulch. The tree fell into the line and caused an outage. The telephone line only was broken. No damage was done to the high tension line which had been grounded through the tree to the telephone and thence to ground. Evidently the road gang was able to clear the tree as only the telephone line had to be repaired by the utility, although the line was cleared for that purpose.

While operating post type air break disconnecting switches in order to sectionalize this line so as to clear the tree trouble, a portion of the stack of post type insulators carrying a live jaw fell in such a way that the loop grounded and caused another outage.

On April 1, 1931 (note the date) an automatic outage occurred on this line. While patrolling it was found that with the spring break-up a 2-pole structure had moved, due to 12 ft. of pondage created by a new power development, sufficiently to transfer loads to the adjacent suspension equipped poles both through the power wires and the telephone wires. The telephone wire connections to the adjacent poles had less flexibility than the suspension insulators and, in the intervening span telephone wires became sufficiently taut to pull up close enough to the power wire to permit of an arc from the power wires to the telephone wires. The wires were found by patrolmen within 1 ft. of one another and they had been damaged by flash-over but not severed.

Doubtless this condition had been accumulating for some time but was not noticed. This would appear to be a case where there was an outage which might be attributed directly to the line itself, being only partially man-made, and was due to atmospheric disturbances. It was not due to lightning storms which was the particular study for which this paper was prepared.

This wood pole line has now been in service 11 years and continues, after a careful study of logs and operating records to operate with only these five interruptions during that period, none of which are due to the elements, excepting possibly the ice-shove of April 1, 1931, against the new crib in an artificial lake, or forebay.

One bushing at the generating end of the line and also one bushing at a 110 kv. customer's plant flashed over

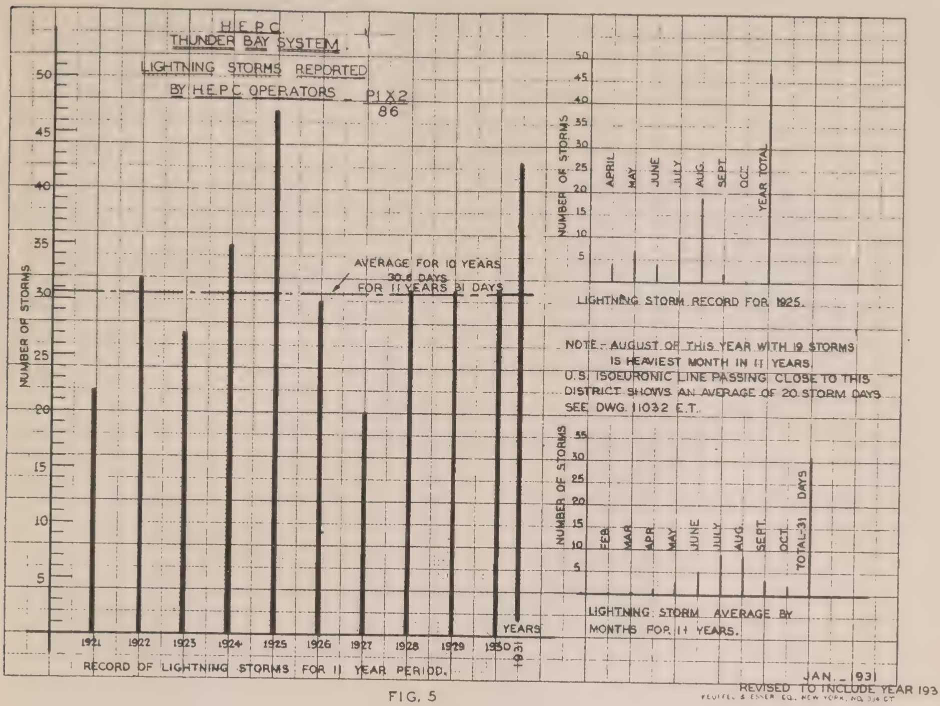


FIG. 5

during lightning storms. Doubtless the line carried a steep wave-front to these stations; however, there is no evidence that the line flashed over at the time of either of these disturbances.

Although there were no interruptions pre-arranged or otherwise, during the first four years of operation, there have been pre-arranged interruptions since the second circuit was available usually for such reasons as the replacement of a very small percentage of insulators, the replacing of one or two poles, the removing and inspection for deterioration of a few suspected cross-arms, and to insert or modify interswitching facilities or remove existing sectionalization switches.

The fact that the aborigines named this district "Thunder Bay" was interesting when the line was being designed and still is because operators now report a greater number of electrical storms than are indicated by the isoeuronic lines of the Weather Bureau of Washington, which were drawn up some years ago after conferring with the Canadian Meteorological Office, at which time only limited reliable data were available. Electrical storm data taken over several years, figure 5, are recorded showing an average of 30 per annum for observing stations.

In the data from which this chart is made up, there are 306 storms reported during 10 years and 106 are reported at two or more stations, from which data it may be assumed that there were 442 storms across or near the 68-mile line, or an average of 44 per year, any one of which might be

expected to have some effect upon the line.

The line was built when both labor and materials were relatively expensive. During the closing years of the war, lines of this sort could be built using No. 0000 A.C.S.R. at about $7,300 per mile, of which $150 should be set aside for right-of-way payments and in addition $900 to cover clearing and the cost of securing easements and lands. Of the $7,300 above, $1,000 should be allowed for engineering, contingent items and various overhead charges. In the meantime, somewhat similar lines have been built for $5,000 per mile.

Measurements have been made which record the relative impedance of these two paralleling lines. When bussed together, the load divides between these two sizes of conductor equally within the correction limits of the instruments used. They are usually operated directly in parallel with one another.

In the year 1924, this type of construction was duplicated in a quite different territory for operation at 25 cycles. It was erected between Oil Springs and Sarnia, at the south end of Lake Huron. This line was 17 miles long and operated first at 26 kv. for two years and then at 110 kv. for 6 years, and had recorded two outages due to lightning during that time, making a rate of 1.9 outages per 100 miles per annum for that portion of the section while operating at 110 kv. This 17 miles forms part of a 66-mile section of wood pole line, the balance of which is "H" frame and this balance of the section has the poorest operating record of almost any part of a quite large suspension equipped 110 kv. system. The outages are practically all due to lightning, and in each case the line goes back into service. The effects of almost every fault have been discovered and can be attributed with the two exceptions mentioned above to the "H" frame portion of the line. It is very difficult to get good grounds for the sky wire in parts of this 66-mile section.

The experience with the circuit in Lake Superior district is unique and must carry a considerable significance because of the operating characteristics of the closely paralleling steel tower line and because of the quite good operation of the 17-mile copied section in older Ontario where lightning storms according to records taken under similar instructions were of about the same frequency—that is, of the order of 30 per annum. The experience in the Thunder Bay district has, however, always been treated as an isolated case and has not influenced a practice extending over a number of years of building lines 110 kv., and over of steel, because that material appears to be considerably more substantial although usually somewhat more expensive. Furthermore, a considerable portion of the 110-kv. lines carry conductor 500,000 cir. mils A.C.S.R and larger, and the organization has not built wood-pole lines to carry larger conductor at that voltage. A fair statement of outages for this large system of interconnected suspension equipped steel tower lines is from 2 to 2½ per 100 miles of circuit per annum for all causes where electrical storms average 30 per annum. The actual figure varies somewhat,

depending upon the period of years used to make up an average figure.

The following characteristics of the line are supplied in accordance with standard procedure of some organizations:

TRANSMISSION LINE CHARACTERISTICS

Company—Hydro-Electric Power Commission of Ontario, Canada.
Section—P1X2 (wishbone construction).
Terminals— Camerons Falls Generation Station to Port Arthur Transformer Station, with line tapped into the Nipigon Pulp Mill with open circuit at that point and in reserve. Alexander Power development was tapped into this line, a distance of some 1,200 ft., in November, 1930.

1. Length on single circuit supports:—68.34 miles + 6 mile tap.
2. Length on double circuit supports:—
3. Normal span:—325 feet.
4. Maximum operating voltage:—110 kv.
5. Frequency:—60 cycles.
6. Date originally placed in operation:—Dec. 20, 1920.
7. Date and nature of subsequent modification:—
9. Number, type and location of lightning arresters:—(1-oxide at Gen. Station — 1-oxide at Pt. Arthur Trans. St.)
10. Neutral dead grounded at the generating station till March, 1931. Since that time it has been fixed by dead grounding of neutral of one 15,000 kv-a. transformer bank at the receiving station marked Port Arthur transformer station on the plan.
11. Location of neutral ground:—Nipigon Gen. Sta. and Port Arthur later.
12. Conductors:—(a) size and material:—No. 0000 A.C.S.R.
    (b) Equivalent spacing:—11 ft.
13. (c) Max. design tension:—2,900 pounds.
    (d) Max. sag in normal span:—4 ft. at + 60 deg. fahr. with ice and wind.
14. Insulators:— Suspension, Number units, per string and type:—7 units, —10 in.
15. Dead-ends:— (a) 9 units.
    (b) Number strings in parallel:—
16. Flashover protection:—Suspension—bottom of string
17. " —top of string
18. Dead-ends —line end of string
19. " —support end of string
20. Ground wire:—Number 1. Size 9/32 in. Material, galv. steel.
21. Location (also shown on sketch):—peak of pole.
22. Method of support:—Rigid or flexible — rigid.
23. Supports:— (a) Type and material — poles wood.
    (b) Total number in line — 1106.
    (c) Designed for light, medium or heavy loading:—heavy.
24. Dimensions of suspension structure:—See figure 2.

This wood pole line will be watched by those who are interested in the operation of it quite closely indeed in future, and no doubt others who have now become familiar with its operating characteristics will be interested to know when the first outage, due to lightning, occurs.

FROM THE HIRED MAN

YES, we owe quite a lot to Marconi and Watt,
And to Edison, Tesla and Wright,
And inventors who scheme over gas, over steam,
To give us more power and light;
They have lessened our fret and our toil and our sweat
And have made life more smooth and serene,
But I hand my applause to whoever it was
That invented the milking machine!

For the worst of the bores on a farm was the chores,
And the milking the worst one of all.
By the dawn's early light and the darkness of night,
In winter, spring, summer and fall.
'Twas the same thing each day in the same stupid way,
A job that was drudging and mean,
And it seemed like a curse that grew steadily worse
Till—along came the milking machine!

Oh, the grumbling I've done when the milking was one
Of the farm's most laborious stunts!
But now I sit and sing while that vacuum thing
Is milking two bossies at once.
And it seems like a dream as I watch the white stream
That shoots through the tubes, pure and clean,
For my hands don't get sore like they used to before
We put in that milking machine!

Now I don't know the name of the man who can claim
The milking machine was his hunch,
But I'm willing to swear it was some guy, somewhere,
Who'd had to milk cows in a bunch.
Some farm hand like me who conceived the idee
And who worked the thing out in his bean,
So that farm hands, could smile while the milking, meanwhile,
Was done by the milking machine!

BERTON BRALEY in the *Country Gentleman.*

HYDRO NEWS ITEMS

Eastern Ontario System

The Municipal Council of Cobourg is submitting to the electors on January 4, 1932, the question of the purchase from the Hydro-Electric Power Commission of Ontario of the local Water and Electric Plants at a price of $295,000.00.

* * * *

Georgian Bay System

The Commission has just completed the entire reconstruction of the distribution systems in the village of Port Elgin and the Town of Walkerton, the work being performed on behalf of the local Commissions of each municipality.

* * * *

The construction of extensions and improvements to the distribution systems in Alliston, Bradford, Creemore, Grand Valley and Ripley have been undertaken by the Commission on behalf of the local Commissions, the principal work being the stringing of new and larger primary and secondary lines, installation of additional transformer capacity, and a general overhauling of the entire distribution systems to take care of increased loads and general maintenance.

* * * *

Northern System

A new 450 kv-a. substation has just been completed and placed in operation by the Commission at the Town of Capreol on behalf of the municipality, and arrangements are progressing satisfactorily in connection with placing this municipality on a cost contract at an early date.

* * * *

Considerable activity has been manifested by the rural districts adjacent to the City of Sudbury, in connection with extensions to rural lines for Hydro service and from investigations already made and meetings held, it is quite probable that several miles of Hydro rural lines will be constructed in this area next year.

* * * *

An investigation is being made and estimates are being prepared covering the cost of two substations and approximately 125 miles of transmission and distribution lines for the purpose of serving the district from Raymore to Porquis Junction, including the villages of Matheson and Monteith, and every effort is being made to complete arrangements for supplying Hydro power in this district next year.

* * * *

Thunder Bay System

A new rural line of approximately nine miles in length was completed and placed in operation in McIntyre Twp., east of Port Arthur during the latter part of December, this being the first instance of distribution of

electric service under the Power Commission Act in rural districts on Thunder Bay System.

* * * *

The City of Fort William has been distributing electrical power in rural districts outside its boundaries for several years past, all of which has been undertaken and financed by the city system. Negotiations are now practically completed for The Hydro-Electric Power Commission of Ontario to take over some ten miles of the city lines in rural districts and to construct an additional fifteen miles of line, contracts for which have already been signed and in the Spring it is expected to inaugurate the Fort William Rural Power District with approximately 25 miles of distribution lines in operation.

Association of Municipal Electrical Utilities

ELECTIONS - 1932

The election ballot for officers of the Association of Municipal Electrical Utilities for 1932 will show the following names as candidates. The ballots will be distributed on the morning of the first day of the Winter Convention, January 27th, 1932, and marked ballots received up to the opening of the afternoon session on that day. The results of the election will be announced before the close of that session.

PRESIDENT: C. E. Schwenger (acclamation).

VICE-PRESIDENT: T. W. Brackinreid and A. B. Scott.

SECRETARY: S. R. A. Clement and W. B. Munroe.

TREASURER: B. Faichney and H. T. Macdonald.

DIRECTORS,—from the Membership at large: Chas. T. Barnes, E. V. Buchanan, R. L. Dobbin, J. E. B. Phelps, R. S. Reynolds, O. H. Scott and E. J. Stapleton.

DISTRICT DIRECTORS:

NIAGARA DISTRICT: W. R. Catton and H. F. Shearer.

CENTRAL DISTRICT: G. E. Chase, J. E. Skidmore and C. A. Walters.

GEORGIAN BAY DIST.: C. E. Brown, H. J. Cameron, G. A. Ferguson, R. S. King and J. R. McLinden.

EASTERN DISTRICT: M. W. Rogers and R. J. Smith.

NORTHERN DISTRICT: R. H. Martindale and C. J. Moors.

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